AGRICULTURAL ENGINEERING

APRIL • 1956

In this Issue . . .

ASAE 49th Annual Meeting • Roanoke, Va., June 17-20

THE JOURNAL OF THE
AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

3 NEW CASE COLOR FILMS ON FARM MECHANIZATION

Here in three new Case color films is the history of men and machines for the farm . . . the step by step progress from hand harvesting to automatic combining . . . the color and romance of the age of steam . . . and the behind-the-scenes story of the launching of the tractors of tomorrow.

You'll want these films for the education of your students, the entertainment of both young and old. See your Case dealer for prints . . . arrange now to show these films to all your students next fall. You are welcome to make use of these and other Case teaching aids—movies, booklets, slide films, posters, study outlines, reprints. J. I. Case Co., Racine, Wis.

"Centennial of Farm Mechanization"

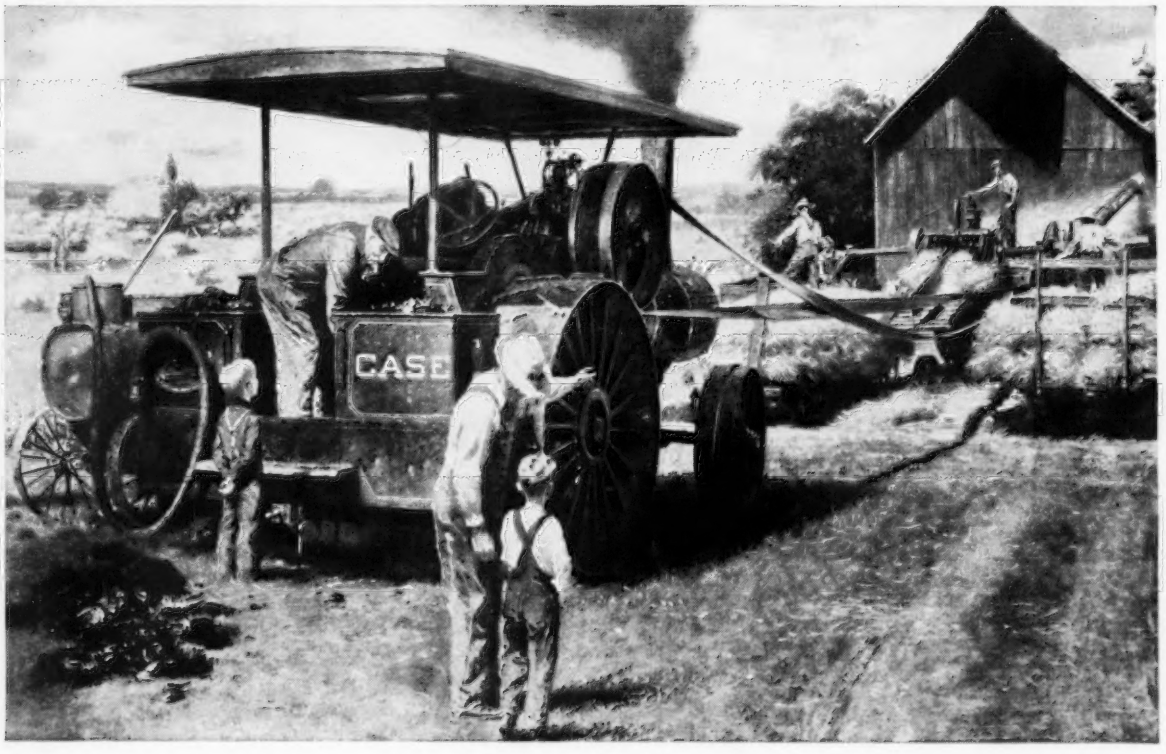
Machines and methods from the past 100 years as shown at Michigan State University's "Centennial of Farm Mechanization" and "Land of Plenty" pageant at Lansing, August 15-19, 1955. Additional operational footage from the extensive Case film library.

"When Steam Was King"

Look at the picture below and remember threshing time when you were a boy, eager to be part of the crew . . . let your audiences relive the days when steam was king . . . show your students the romance and excitement of the steam age. See steamers on parade!

"Operation Tractor Launching"

How a major manufacturer introduces a new tractor to his own organization . . . trains service men . . . and finally, presents it to dealers and farmers in field demonstrations is told in this newest of Case films, first of its kind in the industry.



Morse Roller Chain provides vital drives in 12-ton-per-hour New Holland Hay Baler

Detail of New Holland Super 77 Hay Baler, showing Morse Double-Pitch Roller Chain on knotter drive. This is one of four vital baler drives utilizing Morse Chain.

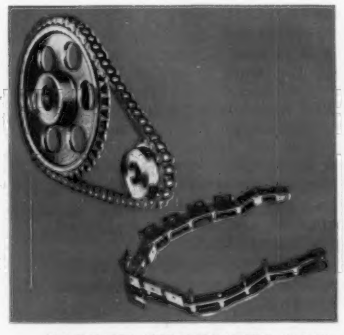
"One of the four places in our new Super 77 Hay Baler where we use Morse Chain is in the vital drive of the knotter assembly," reports New Holland Machine Company (New Holland, Penn.), leading agricultural equipment manufacturers. "This one important chain controls the plunger action while the bale is being tied.

"From long experience in manufacturing grassland equipment, New Holland knows how important the action of this one chain is in the knotter assembly. The chain's reliability can make or break a farmer's baling record for the day or for the season."

Leading farm machine makers across the country depend on Morse for power transmission equipment. Morse makes a complete line of roller chain, couplings, sprockets, torque limiters, and special-purpose roller chain attachments for conveyors, etc.

Free help and information

Write, wire, or call today for information on any phase of your product development which involves power transmission. Or call in our local expert, your nearby Morse Distributor.



MORSE PRODUCTS FOR AGRICULTURAL EQUIPMENT

Morse Roller Chain Drive. Special double-pitch chain mockup, showing variety of special attachments.

Morse Roller Chain Couplings, Morflex Flexible Couplings, adjustable Morse Torque Limiter.

MORSE CHAIN COMPANY
INDUSTRIAL SALES DIVISION
ITHACA, N.Y.

MORSE MORSE B-W BORG-WARNER *

POWER TRANSMISSION PRODUCTS

*trademark

AGRICULTURAL ENGINEERING

Established 1920

CONTENTS • APRIL, 1956 • VOL. 37, NO. 4

AGRICULTURAL ENGINEERING is owned and published monthly by the American Society of Agricultural Engineers. Editorial, subscription and advertising departments are at the central office of the Society, 420 Main St., St. Joseph, Mich. (Telephone: YUkon 3-2700).

RAYMOND OLNEY
Editor and Publisher

JAMES BASSELMAN
Associate Editor

SUBSCRIPTION PRICE: $5.00 a year, plus an extra postage charge to all countries to which the second-class postage rate does not apply; to ASAE members anywhere, $3.00 a year. Single copies (current), 50 cents each.

POST OFFICE ENTRY: Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921.

The **TORRINGTON NEEDLE BEARING** *is a natural for volume installation*

You can install Torrington Needle Bearings with greater rapidity than any other type of anti-friction bearing. Today, automatic arbor presses are widely used throughout industry for large volume installation—possible because of the Needle Bearing's unique unit construction.

Since no collars, shoulders or retaining rings are needed, Needle Bearings require only a simple housing. Consequently, an operator can turn out a tremendous number of assemblies every hour. A surface-hardened shaft serves as the inner race. Ease and speed of installation cut costs on your assembly line—a large production benefit.

For more than twenty years our Engineering Department has helped designers and manufacturers throughout industry to adapt the superior advantages of the Needle Bearing to their products. Let us help you make the Needle Bearing "standard" equipment in yours.

See our new Needle Bearing Catalog in the 1956 Sweet's Product Design File —or write direct for a catalog.

TORRINGTON NEEDLE BEARINGS
Give you these benefits

- low coefficient of starting and running friction
- full complement of rollers
- unequalled radial load capacity
- low unit cost
- long service life
- compactness and light weight
- runs directly on hardened shafts
- permits use of larger and stiffer shafts

THE TORRINGTON COMPANY
Torrington, Conn. • South Bend 21, Ind.
District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON BEARINGS

Needle • Spherical Roller • Tapered Roller • Cylindrical Roller • Ball • Needle Rollers

Ford Rotary Cutter mows a 5-ft. swath

Warner Gear Boxes Help Ford Farming "Get More Done...at Lower Cost"

Combine Gear Box

Cutter Gear Box

Check These Warner Gear Box Features

- Automotive type gearing
- Carburized and hardened alloy gears
- Anti-friction bearings throughout, individually selected for load
- Integrally forged gear and shaft
- Malleable iron housings

ENGINEERING B-W PRODUCTION

WARNER AUTOMOTIVE PARTS DIVISION

"Products of Experience"

Ford 6-ft. PTO Combine for all types of crops

Whatever the implement, all Ford Farming equipment is designed and engineered to help the farmer "get more done . . . at lower cost."

The new Ford 6-ft. PTO-drive combine and the Ford heavy-duty rotary cutter are two good examples. Both are built for top performance, low-cost operation, long life.

And both are equipped with custom designed Warner Gear Boxes to transmit power efficiently and dependably, and to withstand heavy shock loads. Each gear box meets the special needs of the individual implement—yet both contain many common parts, thus providing substantial savings in cost.

What's YOUR Gear Box Problem?

If you have a gear box problem—for field cutter, combine, hay baler, forage harvester, corn picker, posthole digger, hammermill—turn it over to Warner Automotive. Our research and experience will save you time and money. No obligation, of course.

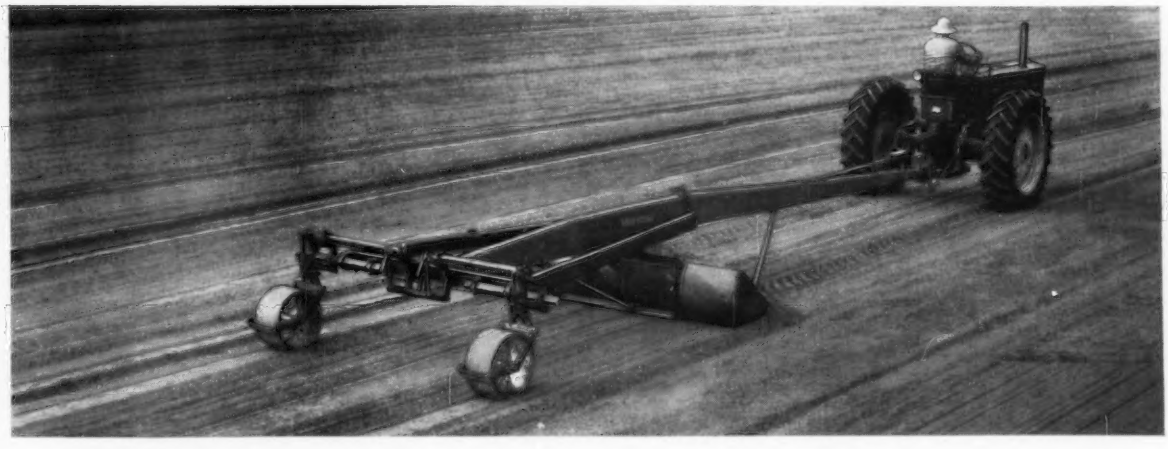
WARNER AUTOMOTIVE PARTS DIVISION

BORG-WARNER CORPORATION • AUBURN, INDIANA

Is This the New Frontier?

BY tradition, irrigation was for the West—for semi-arid plateaus and fertile valleys where spring comes cool and green, then fades and burns beneath the summer sun.

And that's just another tradition that farmers have broken to smithereens. As long ago as 1900, irrigation was being used large-scale by Louisiana rice growers. As time went on, farmers here and there began to pump from streams and ponds and wells until, in recent years, thousands have turned to sprinkling systems—east, north, southeast, and everywhere between.



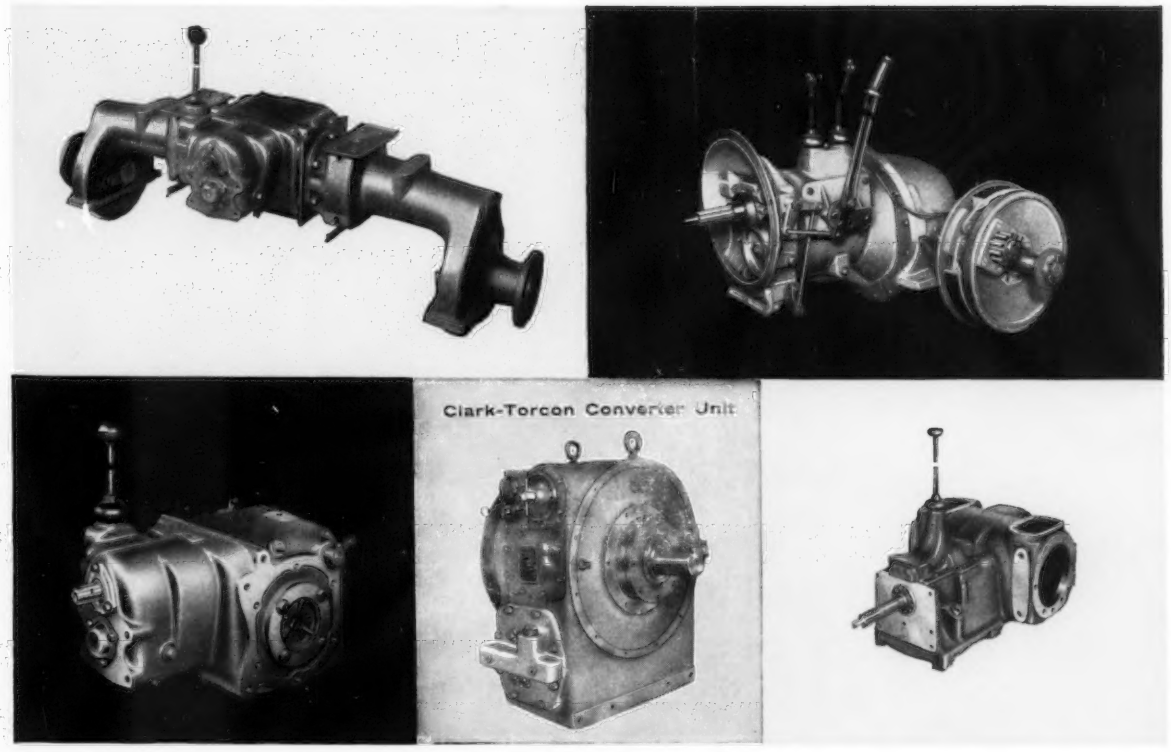
WHERE there's irrigation, there's the need to level and smooth the land. One engineer summed up the trend this way: Land leveling moves east—to the Corn Belt and the Mississippi delta, to the Carolinas, to New Jersey, and Virginia.

Here then, indeed, is a new frontier—in the extension of irrigation, in the conditioning of land for better use of irrigation water, and in the adaptation of farm equipment to new tasks.

Irrigation engineers offer this word of warning. The newcomers to irrigation, if they are wise, may well consider this one big lesson from the experience of old-timers in the business: *Irrigation is wonderful, but it's no miracle.* It costs money, and it has its problems—every farmer must learn how best to adapt it to his farm, how to live with it successfully, what equipment is necessary, when to apply water, when not to, and how much.

To the men who are diligent and patient enough to find the answers to such questions, irrigation does offer tremendous possibilities. History proves that.

JOHN DEERE • Moline, Illinois



How to Design for a Need

Each of these drive units is special—designed for a particular machine, designed to meet a particular need: designed with the collaboration of Clark engineers, in order to utilize Clark's unique experience in the basic field of transmitting horsepower to wheels and tracks.

In this modern era of bold and resourceful engineering, this is precisely the right way to design the "works" of an industrial machine—*design to satisfy a need.*

These manufacturers agree that it's good business to do business with Clark Equipment.

Send for attractive pocket-size booklet "Products of Clark".

CLARK EQUIPMENT CO.
JACKSON, MICHIGAN
Other Plants:
Buchanan, Battle Creek, Benton Harbor, Michigan

CLARK® EQUIPMENT

to combines equipped with this
NEW SELF-LEVELING DRIVING AXLE!

For years, wheat growers had urged farm equipment manufacturers to develop a combine that would permit harvesting on the contour. What was needed was a driving axle that would enable a combine to operate on steep hillsides *without* tilting the separator table.

Many major builders of farm equipment had tackled this job. But every suggested solution seemed too expensive and impracticable. And so, around the country, small shops put together special assemblies for farmers who could afford the heavy cost.

Then, one of the largest of all farm equipment manufacturers called in Timken-Detroit® Axle. Could TDA® engineers help solve this baffler? Well, if there is one thing Timken-Detroit Axle knows, it's axles.

The engineers went to work. Forty years of axle-building know-how and experience were brought to bear on the problem. Result: the manufacturer was able to develop a new *production axle* with a "built-in sense of balance." Now all fields are flat in the wheat country.

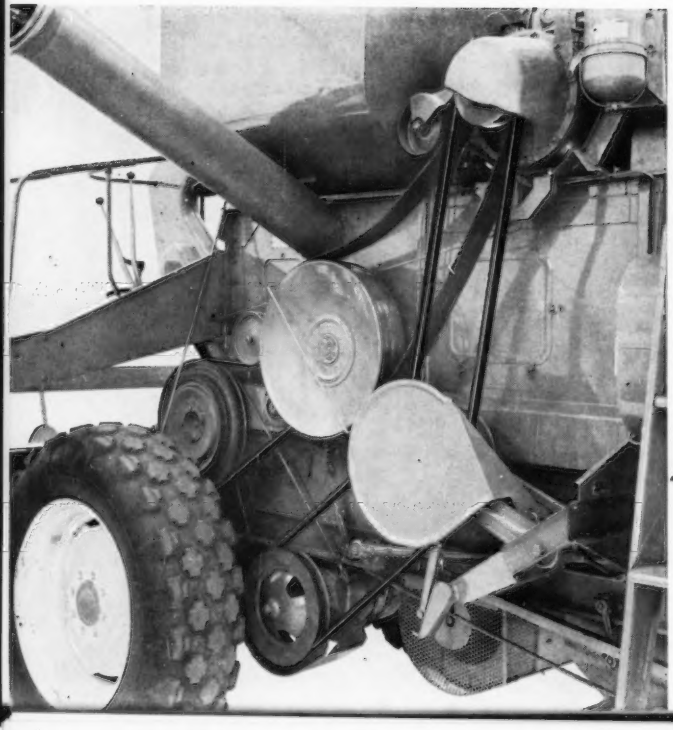
Once again, Timken-Detroit Axle experience proves it is more economical for farm manufacturers to draw on *specialists* for *special* components. If you have a problem in designing or building farm equipment, call in Timken-Detroit Axle engineers. It costs you nothing and it will prove very helpful.

TIMKEN Detroit AXLES
TIMKEN DETROIT AXLE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
DETROIT 32, MICHIGAN
Accepted Standard
TRADE MARK REGISTERED

Plants at: Detroit, Michigan • Oshkosh, Wisconsin • Utica, New York
Ashtabula, Kenton and Newark, Ohio • New Castle, Pennsylvania

DAYTON V-BELTS

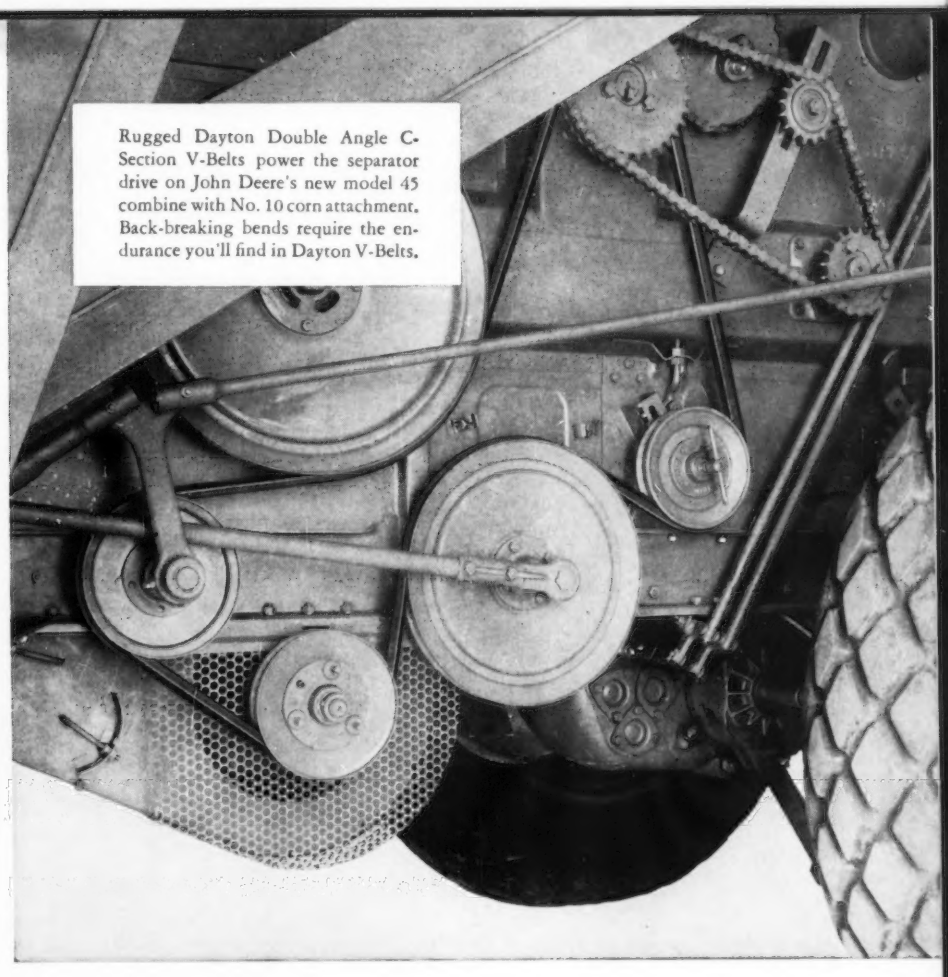
John Deere 45 Combine



Something entirely new in combine versatility is John Deere's new self-propelled model 45 with No. 10 corn attachment. Field-test-proved, the new corn harvester combines up to 20 acres per day. Picking, shelling and cleaning two rows at a sweep, this new machine is setting records for corn growers and custom operators everywhere.

Helping set these records are sturdy C-Section Double Angle Dayton V-Belts that power the separator drive—most brutal of all implement drives. In addition, all other John Deere drives are 100% approved for Dayton V-Belts to include the Selective Ground Control Speed Control drive that permits combining at a wide range of speed.

Selective Ground Control Speed Control drive on 45 is also Dayton equipped. As with all V-drives these Dayton V-Belts received full slug load tests at Dayton and John Deere laboratories, as well as in the field, prior to selection as component drives.



Rugged Dayton Double Angle C-Section V-Belts power the separator drive on John Deere's new model 45 combine with No. 10 corn attachment. Back-breaking bends require the endurance you'll find in Dayton V-Belts.

drive new corn combine

with Corn attachment picks, shells, cleans up to 20 acres per day

With the new No. 10 corn attachment, which can be easily mounted by two men in less than an hour, corn is snapped and augured directly into the combine threshing unit, where it is shelled, separated and cleaned thus saving time, labor and storage area. Users report up to 75% reduction in field losses with the new No. 10 attachment. This, plus the ability to combine 20 acres per day, even in corn having 30% moisture content, makes John Deere's new unit one of the most remarkable improvements for farm use. In addition to combining corn, the 45 with regular grain platform handles wheat, maize, beans and all other combinable crops.

To insure fully adequate power for this modern self-propelled unit, Dayton Field Engineers worked hand-in-hand with John Deere technicians in the laboratory and in the field. That same technical V-Belt skill is available for the solution to your V-drive problems. Just write for details to Dayton Rubber Co., Agricultural Div., 1500 S. Western Ave., Chicago, Ill.

Dayton Double Angle V-Belt
Specially designed with super strength load-carrying section for applications where power must be transmitted from both sides of the belt.

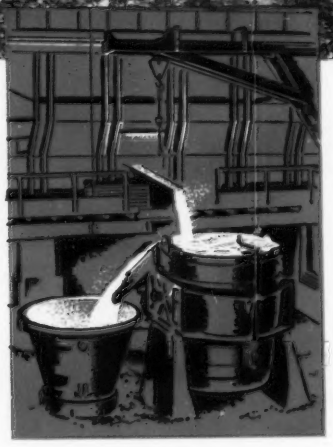
Dayton 51 Rubber
YEARS OF PROGRESS

First in Agricultural V-Belts

Agricultural Sales Engineers in Chicago, Moline, Dayton, New York, San Francisco, Cleveland and St. Louis

LaBelle discs stay sharp longer...

Many John Deere implements like this Pick-up Disk Harrow are equipped with Crucible LaBelle discs.



. . . *this field advantage 'is built in here!*

When you specify Crucible LaBelle discs, you insure better performance in the field. Here's why:

At Crucible, *disc* steel is as much a special purpose steel as *tool* and *stainless*. In every phase of production, from melting through fabricating, special steps are taken to produce LaBelle quality. One example: grinding is done prior to heat treating to insure a better edge. All this is done by Crucible's specialty steelmen . . . to *build-in* LaBelle's field advantage: a longer lasting edge that performs better in any type of soil.

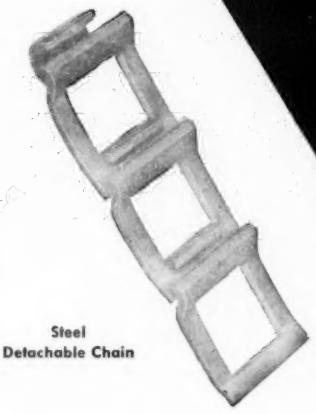
Crucible LaBelle discs are available for any make of plow or harrow . . . or for any soil condition. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

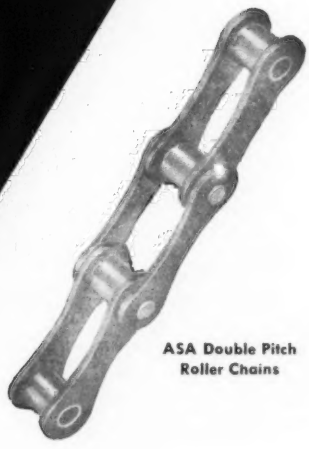
Crucible Steel Company of America

CHAIN BELT

fills the gap



Steel
Detachable Chain



ASA Double Pitch
Roller Chains

in

IMPLEMENT CHAINS...

NEW "HF" Steel Detachable Chains

NEW "A" Series Double Pitch Roller Chains

NEW "AR" Series Rollerless Chains

Here's the long-sought answer to an implement designer's dream—a *complete* series of implement chains that answers every need... cost, service, strength!

NEW "HF" (High Fatigue Strength) Series Steel Detachable Chain is the answer for a stronger, longer-lasting steel detachable chain in many implement applications—at a moderately increased cost. It operates over the same sprockets as standard steel detachable chains.

NEW "A" Series Double Pitch Roller Chain is a low-cost substitute for ASA double pitch chains on many applications. It is similar in design and capacity range as ASA double pitch chain but does not have as fine an appearance or the high precision manufacture.

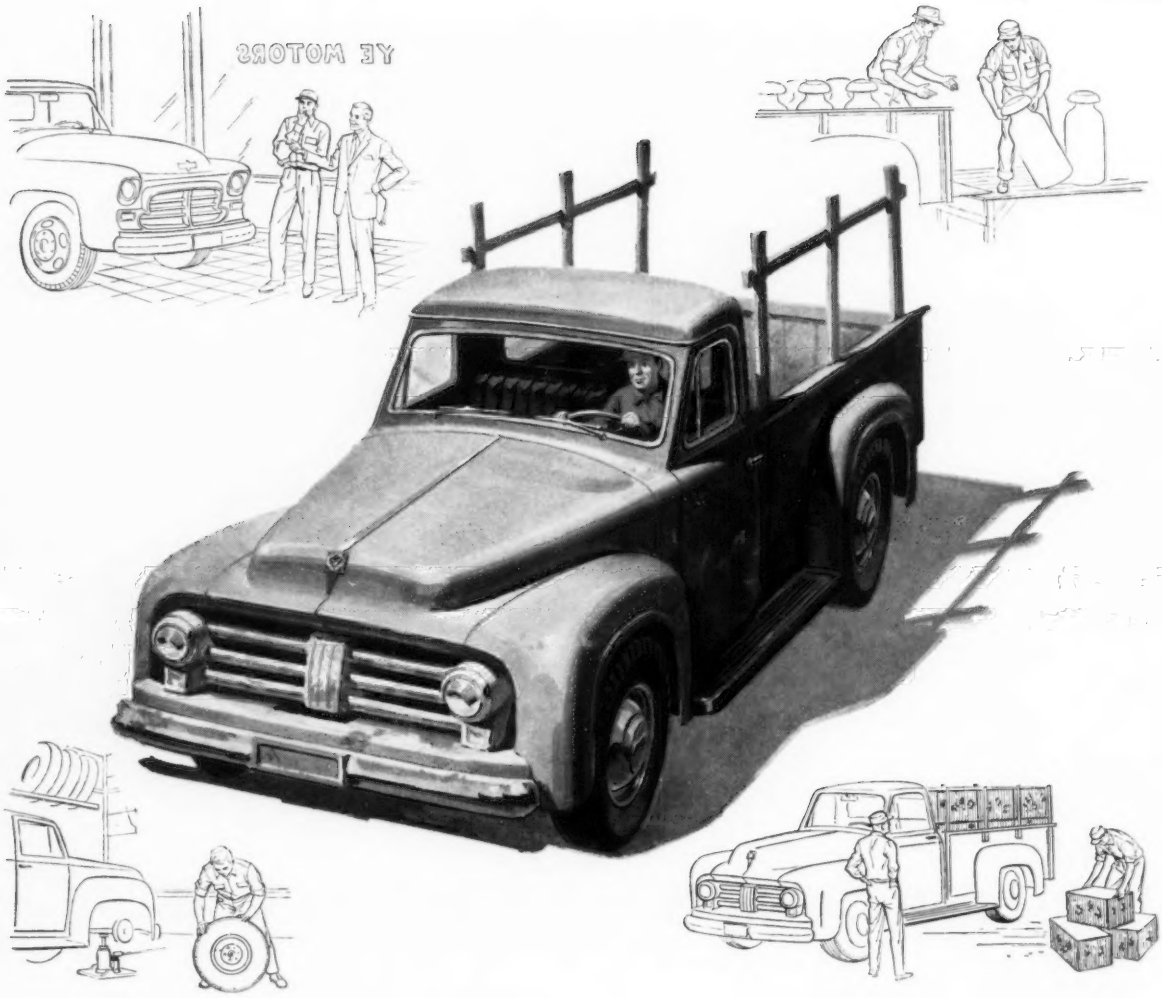
NEW "AR" Series Implement Chain answers the need for a chain with increased strength and wear resistance. It is especially designed with a larger diameter pin for greater wear life. This chain also assures greater resistance to stiff chain joints and will handle a greater degree of misalignment. It operates on the same sprockets as ASA double pitch and "A" Series double pitch roller chains.

These new chains fill the gap in implement chains. They are *not* a complete substitute for steel detachable and ASA double pitch chains since there are many applications where the use of ASA standard chains is compulsory.

Why not have your CHAIN Belt Field Engineer give you the complete facts? Call him or write CHAIN Belt Company, 4680 W. Greenfield Ave., Milwaukee 1, Wis.

CHAIN BELT COMPANY

Milwaukee 1, Wisconsin



Look at the farmer's truck...

you'll see why it's easier to sell a gasoline tractor

A new tractor isn't the only piece of farm machinery that must come out of the farmer's budget. He must maintain his other equipment and plan for the day when he'll also need a new truck.

That's why the lower purchase price of gasoline tractors can help make the sale for you. With the money saved, the farmer may see his way clear to have a new tractor and his truck, too.

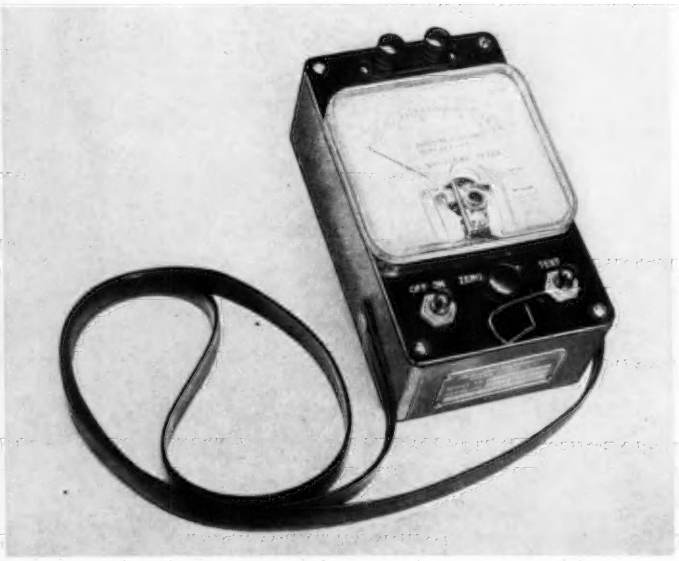
But price is only one of the many selling advantages of gasoline tractors. Today's improved models deliver up to 30% more power . . . give greater all-round convenience. They require less maintenance—have a greater trade-in value when the time comes for the farmer to again buy a new one.

So, next time you are talking tractors . . . think of the farmer's truck. You'll be headed for an easier gasoline tractor sale.

ETHYL CORPORATION

NEW YORK 17, N. Y.

the improved BOUYOUCOS MOISTURE METER



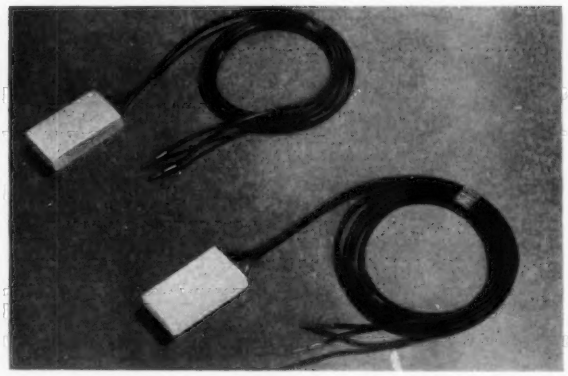
SCIENTIFIC GUIDE TO IRRIGATION

Here is the famous Bouyoucos Moisture Meter — known and proved by farmers throughout the world as the practical, accurate guide to proper irrigation.

Operation is simple. Special soil blocks are buried permanently at root level of the crop. Lead wires protruding to the surface of the ground are connected to the Moisture Meter to take a reading. Meter scale is marked directly in percentage of soil moisture — so immediately you have an accurate measurement.

This relatively inexpensive equipment can save you money and trouble in unnecessary irrigating. At the same time it assures greater crop yields through proper soil moisture content.

Electronically, the Bouyoucos Moisture Meter represents the latest design. It employs transistors in place of vacuum tubes for longer battery life and less maintenance. It is dependable, rugged and accurate. Self-contained flashlight batteries supply necessary electric power.



Special soil blocks for use with Moisture Meter have stainless steel electrodes and are plastic impregnated for longest service life.

PRICES:

BN-1 Moisture Meter complete with batteries and soil block ready to operate **$87.00**
Extra soil blocks ..... **2.00 ea.**

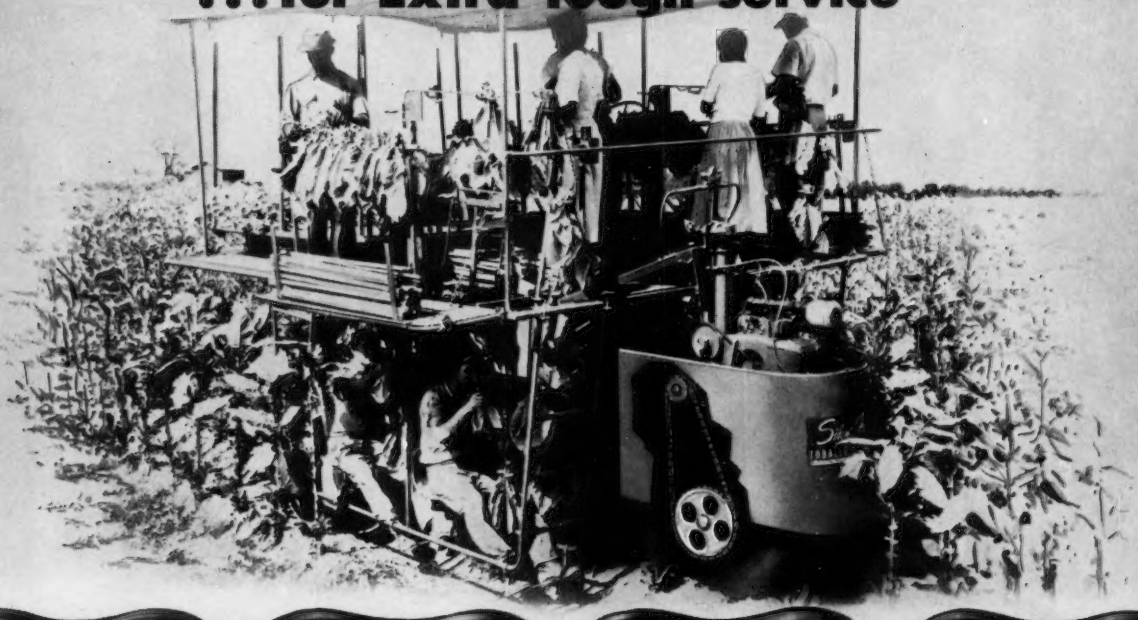
WRITE FOR COMPLETE LITERATURE . . .

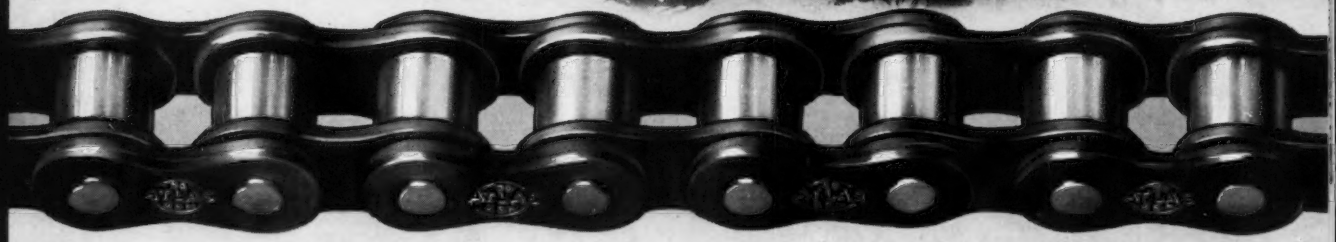
Industrial Instruments

Industrial Instruments INC.
89 COMMERCE ROAD
CEDAR GROVE, N. J., U.S.A.

SELF-CLEANING... ABRASION RESISTANT

...for Extra tough service





Revolutionary Tobacco Harvesters

Rely on ATLAS CHAIN to keep going in mud and sand

Tough abrasive action of sand, dirt and mud is the type of punishment Atlas Chain and Sprockets must take on this "Silent Flame" Tobacco Harvester manufactured by the Long Manufacturing Company. The chain and sprockets are bombarded by an endless stream of dirt kicked up by the wheels and at times actually operates with the chain churning a path out of the mud and sand.

This is the type of service that has proved the extra wear built into every link of Atlas Chain. Plates, pins and bushings are super-toughened by Atlas' exclusive heat treating process assuring stronger operating chain over longer periods. Rollers, pins and bushings are "Micro-Finished" to exact tolerances for smooth, quiet operation.

Whether a standard pitch chain as used on the drive . . . a special extended pitch as on the leaf conveyor . . . or the sprockets throughout the harvester, Atlas makes a complete line of precision matched chain and sprockets to meet every requirement. Write for your copy of the new handbook on chain and sprockets ARC-55.

ATLAS CHAIN & MANUFACTURING COMPANY · WEST PITTSTON, PENNA.

ATLAS ROLLER CHAIN AND SPROCKETS

for the farmers and ranchers in your area:

TIPS ON BETTER FARM FENCING

No. 2

FROM UNITED STATES STEEL

Figure 1

field measuring example

Figure 1 shows part of a typical aerial photo of a farm. Taking field 3 as a fencing example, we find by measuring the four sides with our printed scale (just as you will do once you have traced your farm onto the attached tracing grid) has the following dimensions:

north fence	900 feet
east fence	960 feet
south fence	900 feet
west fence	840 feet
total	3600 feet

Since the total distance around field 3 is 3600 feet, we can convert to rods by dividing 3600 feet by 16½ feet. Although the answer is 218.18 rods, we will assume the distance around field 3 to be 219 rods

that it is known that Field 3 has a rods it can be seen that the needed and their

materials required for field 3

Woven wire— 219 rods (11 20-rod rolls)
Barbed wire— 219 rods (3 80-rod rolls)
Smooth wire for bracing—
One 50-pound bundle (about 855 feet)
One 25-pound bundle (about 428 feet)
—allowing 40 feet for each diagonal brace.
Pressure Creosoted line posts—
215 (If one stretcher post assembly—line brace—is desired in each of the four fences enclosing our example, 8 line posts would have to be added to this number).
Pressure Creosoted corner posts—4
Pressure Creosoted horizontal corner braces—16
Staples— 33 pounds at 72 per pound. (Use 10 to 12 per post, putting a staple over each wire at

The figures and diagrams above show farmers and ranchers how to figure their fence needs and cost accurately before buying fence materials. This is just one example of the many helpful suggestions that appear in the three United States Steel folders—"Fence Planning Saves," "Fences That Pay," and "A Boring Tale." You can help the farmers and ranchers in your area to have better and lower cost fencing by giving them these informative folders. To get your free supply, just send in the convenient coupon below.

Advantages of pressure-creosoted fence posts:

- **service life of 30 years or more**
- **less replacements**
- **low annual cost**
- **resistance to termites, fungi, rot, moisture, adverse climatic and soil conditions**

UNITED STATES STEEL — USS CREOSOTE

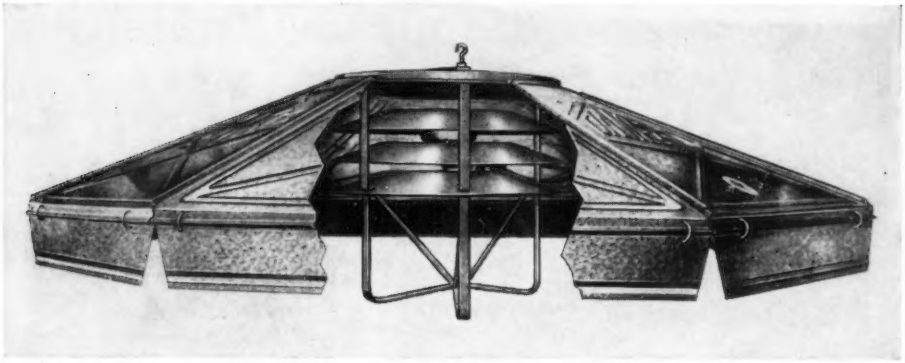
Agricultural Extension, Room 5261
United States Steel Corporation
525 William Penn Place, Pittsburgh 30, Pa.

Please send me a free supply of the United States Steel folders on pressure-creosoted wood.

Name .....

Address .....

City ..... **State**.....



Poultry brooders illustrate how ALUMINIZED STEEL can step up efficiency and lengthen the service life of products exposed to heat.

If Heat is Your Product-Problem...

See What Armco ALUMINIZED STEEL Can Do

Engineers have found that designing parts for a product that reflects and resists heat requires a material with four special qualities for balanced design. These are good reflectivity to control the heat, good heat resistance to avoid oxidation or destructive scaling, strength to assure structural rigidity, and low cost to meet competition. Armco ALUMINIZED STEEL (Type 1) combines all these qualities.

Here's Why:

1. Reflectivity—It reflects approximately 80 per cent of the radiant heat thrown against it at operating temperatures up to 900 F.

2. Heat resistance—Resists destructive scaling up to 1250 F.

3. Strength—Same as the steel base. For example, at 800 F, it has more than 10 times the strength of aluminum.

4. Cost—Even when considering equal thicknesses, costs less than aluminum. Strength of the steel base usually permits gage reduction for additional savings.

Helps Brooder Designer

Here's how a large manufacturer of brooders gets more uniform heat distribution and longer service life from heated parts with Armco ALUMINIZED STEEL.

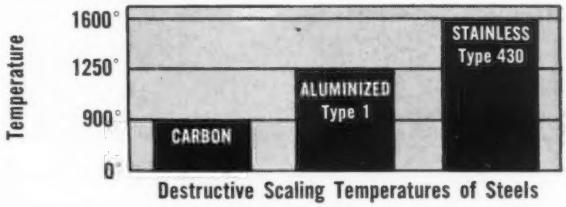
Reflectors made of ALUMINIZED STEEL are placed above the burners. Because of its high reflectivity, this special steel provides even distribution of heat, more efficiency from the burners. Result: powerful new selling points.

This manufacturer also uses ALUMINIZED STEEL as a flame deflector above the burner. While reflector temperatures may vary from 450 F at the outer edge to 900 F near the flame, deflector temperatures go even higher.

Other Farm Applications

Armco ALUMINIZED STEEL (Type 1) has also proved to be an efficient and low cost material for heat exchangers in crop dryers, tobacco curing stoves, tractor mufflers, and other applications where heat resistance, heat reflectivity, strength, and low cost are required.

For complete information on how Armco ALUMINIZED STEEL can help you solve heat problems in your products, just fill in and mail the coupon.



Destructive Scaling Temperatures of Steels

Another grade of Armco ALUMINIZED STEEL, known as Type 2, is ideal for products exposed to atmospheric corrosion. It combines the atmospheric corrosion resisting properties of aluminum with the strength of steel in buildings, roof decks, carports, roofs for silos and water tanks, and rolling doors.

ARMCO STEEL CORPORATION
1226 Curtis Street, Middletown, Ohio
Please send further information on ALUMINIZED STEEL:
☐ Type 1 ☐ Type 2

We manufacture_____
Name_____
Company_____
Address_____
City_____ Zone____ State_____

ARMCO STEEL CORPORATION

1226 CURTIS STREET, MIDDLETOWN, OHIO

ARMCO®

SHEFFIELD STEEL DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION

Electric Conveyor with PRE-SET GATE-DUMPER

Saves Labor in Stacking Bales

Conveyor takes bale to runway at top of barn, from which it is dropped at desired place by presetting the gate dumper. Don Rogier *(left)* demonstrates labor saver to Malcolm Herbst, Texaco Distributor of Highland, Ill. Marfak lubricant keeps conveyor running smoothly, seals out dust and dirt, prevents wear and fights rust.

STACKING bales of hay in the barn of the Rogier stock farm, near Highland, Ill., has become an easy chore, requiring the work of one less man, since an electric conveyor with dumping device has been installed.

The conveyor takes each bale along the top of the barn. The operator merely changes the gate setting so that the bales are dumped where he wants them.

Dwight C. Rogier and his son Don have found that labor-saving machinery pays for itself. They have also found that *it pays to farm with Texaco products.* They like the neighborly service they get from Texaco Distributor Malcom Herbst.

In Town or on the Highway— in all 48 states, dependable Texaco service is available with these outstanding products: top octane Sky Chief gasoline, super-charged with Petrox, to give maximum power and reduce engine wear... famous Fire Chief at *regular* gasoline price, both 100 per cent *Climate-Controlled*... Advanced Custom-Made Havoline Motor Oil and Marfak lubrication.

Farmers get neighborly on-time service, a square deal and top quality products from Texaco Consignees or Distributors. Consignee C. J. Field *(right),* Mission, Texas, has just delivered a tankful of Fire Chief, the gasoline with superior *"Fire-Power"* for low-cost operation, at F. G. Goates' *(left)* farm.

Advanced Custom-Made Havoline Motor Oil wear-proofs engines of tractors, trucks and cars for longer trouble-free life... keeps them cleaner, freer from carbon and sludge — so they deliver maximum power. Consignee F. E. Churchill *(left)* of Middlebury, Vt., discusses Havoline with Conrad Aubé, who farms 350 acres.

THE TEXAS COMPANY

ON FARM AND HIGHWAY IT PAYS TO USE TEXACO PRODUCTS

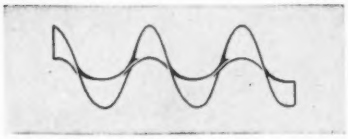
DIVISION OFFICES: Atlanta, Ga.; Boston 16, Mass.; Buffalo 9, N. Y.; Butte, Mont.; Chicago 4, Ill.; Dallas 2, Tex.; Denver 3, Colo.; Houston 2, Tex.; Indianapolis 1, Ind.; Los Angeles 15, Calif.; Minneapolis 3, Minn.; New Orleans 16, La.; New York 17, N. Y.; Norfolk 10, Va.; Seattle 1, Wash.

Texaco Petroleum Products are Manufactured and Distributed in Canada by McColl-Frontenac Oil Company Limited.

How LINK-BELT makes it easy to **work augers into your design**

WHERE augers are a vital part of any equipment, here's the sure way to better equipment design. Link-Belt augers are available in a full range of diameters, gauges and pitches . . . in any suitable metal to meet your most exacting requirements. And they're simple and compact, accurately made to insure dependable operation.

For any design problem involving augers ask the Link-Belt office near you for engineering assistance.



SELECTED FLIGHTING for all your auger needs. Helicoid, sectional or a range of other types are available in the metal and finish best suited for your design.

SIMPLICITY OF CONSTRUCTION and sturdy design of Link-Belt augers provide dependable, efficient operation on your machine. One basic assembly — no other moving parts to break down.

The complete auger, for gathering cut grain back of the sickle bar, is furnished by Link-Belt for this harvester-thresher.

YOUR CHOICE OF METALS answers your requirements for handling corrosive or abrasive materials. And Link-Belt uses only specially selected steels.

ENGINEERING SERVICES. Our auger specialists will help to analyze your special needs . . . integrate all elements of your design for overall system efficiency.

ALL COMPONENTS — conveyor screws, collars, couplings, hangers, troughs, trough ends, flanges, drives—are available for every design.

LINK-BELT

FARM MACHINE AUGERS

Get in touch with the nearest Link-Belt office for your copy of Screw Conveyor Data Book 2289 . . . today.

14,052

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

Caterpillar Diesel D6 Tractor *at work in beet field. Caterpillar Diesel Tractors use oil filters and refills made by Purolator to Caterpillar's rigid specifications.*

PUROLATOR stands for

Longer Engine Life . . . More Dependable Tractor Operation

With farm acreage up in all sections of the country, efficient tractor operation is, more than ever, an economic "must."

Today's farmer places so much dependence upon his tractor that at peak activity just a half day's "downtime" can virtually wipe out his profits.

To keep "downtime" to a minimum, tractor makers today give top attention to efficient oil filtration, a vital key to dependable, long-lived engine operation.

PUROLATOR
WORLD'S FINEST OIL FILTER

5 reasons why more tractor manufacturers specify Purolator-built filters and refills than any other make

1. Purolator's famous "accordion-pleated" Micronic filter element has *up to ten times more filtering area than ordinary types.*

2. Electron micrographs prove that Purolator Micronic filters *stop particles down to submicrons—.0000039 in.*

3. The pleated design of the Purolator Micronic filter element provides *many times more dirt storage space than old-style filters.*

4. With its larger filtering area, the Purolator Micronic filter element introduces a remarkably small pressure drop into the lubricating system . . . *permitting pumps of practical size and simple type.*

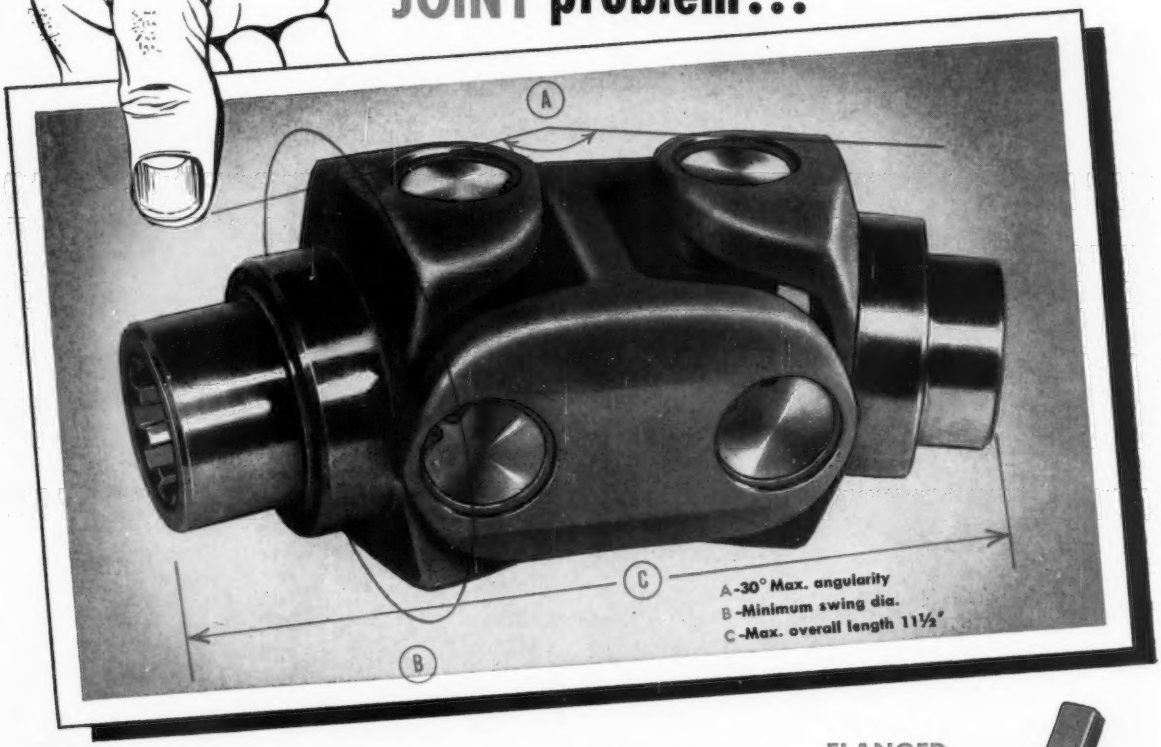
5. With Purolator Micronic filtration, the tractor operator keeps all the oil quality he pays for. *The Micronic filter element will not strip additives* . . . an important advantage with HD and heat-resistant oils.

For further information write, wire or phone:
PUROLATOR PRODUCTS, INC.
Rahway, New Jersey and Toronto, Ontario, Canada.
Factory Branch Offices: Chicago, Detroit, Los Angeles

"Purolator," "Micronic," Reg. U. S. Pat. Off.

BLOOD BROTHERS helps solve another UNIVERSAL JOINT problem...

WHAT'S NEW AT BLOOD BROTHERS



PROBLEM: A well-known product engineering firm, designing a specialized mobile, diesel-driven machine, required special universal joints to transmit power to rubber-tired all-steering wheels. Joint length and diameter were limited by unusual space restrictions, yet heavy torque loads were expected at angles to 30°.

ACTION: As the designers had worked with Blood Brothers on universals for the unit's conveyor, they sent us experimental joints previously handmade for a larger machine.

SOLUTION: After study of the problem, Blood Brothers' engineers proposed certain alterations, resulting in production and tooling savings.

RESULT: Customer-supplier cooperation helped produce a non-standard joint which successfully meets both cost and operating conditions.

Very likely, your needs can be met with standard components, as Blood Brothers builds more types and sizes of universal joints than any other manufacturer. But standard or special, our engineers are willing and able to cooperate with you. Just write or call.

FLANGED STRAP-YOKE JOINT

In contrast to the heavy-duty joint above, it suggests the wide range of types and sizes offered by Blood Brothers.

For your convenience in specifying requirements, write for copies of this Blank Form "Specification Sheet". They're free!

BLOOD BROTHERS MACHINE DIVISION

ROCKWELL SPRING AND AXLE COMPANY

ALLEGAN, MICHIGAN

UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

Technical-ities

By John S. Davey

The Proper Loading of Bolts

The pre-load, or residual tension, in a tightened bolt means more to assembly strength than the actual strength of the bolt itself.

In a joint, a bolt torqued to its proper load level resists a maximum amount of external load without loosening. Designers can take advantage of this fact and assure better results, and at the same time, cut costs.

For example: One designer calculated that truck frames needed high strength bolts at least ½" in diameter. So he used ⅝". But on the assembly line, these were being torqued to 100 ft.-lbs. whereas they needed at least 200 ft.-lbs. for proper residual tension. The ½" bolt at 100 ft.-lbs. would actually have given the stronger assembly and at less cost.

In another case, the bucket on earth moving equipment was always coming loose. The design engineer kept increasing the size of the bolt up to 1¼", but to no avail. The impact wrench used was supplying far too little torque for this size. We suggested a return to the original ¾" bolt used, set up to 350 ft.-lbs. torque. It solved the problem.

In short, the more you stress a bolt within its elastic limit, the greater its ability to stay tight and make a strong assembly.

Symmetrical flow lines assure strong bolt heads

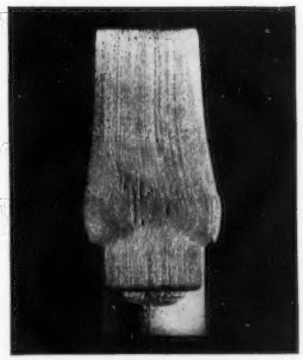


Photo of perfect cold worked blank after first upset.

Effect of improper forming is a poor head like this.

IN THE manufacture of bolts and cap screws, the first upset of metal is a vital one. It determines the flow lines in the bulb which will form the head. A symmetrical flow assures no laps and, therefore, no weak spots or cracks in the final upset of the head.

MACHINE OPERATOR'S SKILL VITAL

The upper photo shows a longitudinal section of a blank after the first upset and on its way to becoming an RB&W standard bolt. Note the even distribution of flow lines. This bulb will become a perfect head.

The lower photo shows what can happen with poor tools, inexperienced operators or without precision setup of the cold headers. Note how pronounced is the unbalanced flow pattern which resulted from a bulb with just a minute defect.

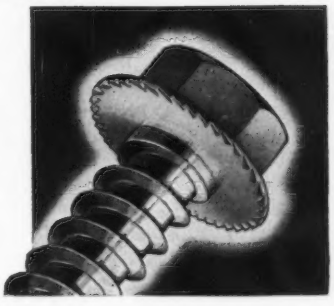
DEPENDABLE FASTENERS

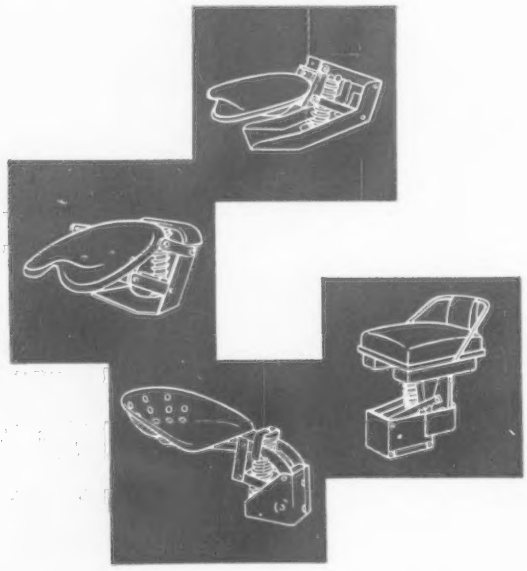
Cap screws and bolts also get a bright smooth finish from the right kind of cold forming. But above all, they offer the designer low cost fasteners with sound internal structure. Standard RB&W fasteners can be loaded to their proper level —become a strong point in any assembly.

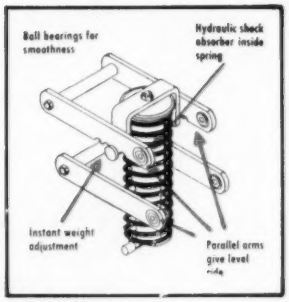
For help on your fastener problem, contact Russell, Burdsall & Ward Bolt and Nut Company. Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

The Only Screw That Stays Tight

The continual heating and cooling caused loosening of handle screws on the flat irons of one manufacturer. Every type tried failed to stay tight until RB&W's unique Spin-Lock tapping screws were used. This solved the problem. Their hardened teeth lock into the surface, require more torque to loosen than to tighten. One piece fasteners, they speed assembly time.

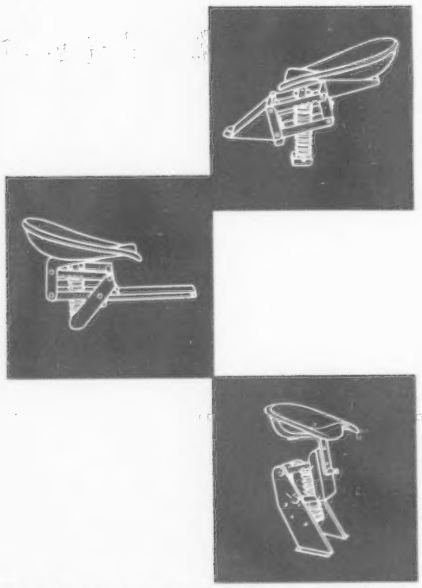






This is the *heart* of the Knoedler Hydraulic Seat—common to all Knoedler models (including those illustrated). It is engineered to fit ahead of, behind or below the seat —making "glide in the ride" adaptable to a wide range of applications.

How a Knoedler Seat puts G-L-I-D-E in the ride



Other features available with various Knoedler seat models include adjustments for fore-and-aft positioning, furrow leveling and slide-back. Accessories include double-linkage tip-back pan seat, upholstered seat, portable underseat tool boxes and air conditioned cushions for pan seats.

For comfort, safety and efficiency, a tractor operator needs a seat that puts glide ———— in place of bounce ~~~~ —and meets these three basic requirements!

1. JOLTS ABSORBED—REBOUND CONTROLLED.

The ride control of a Knoedler Seat is a shock absorber inside a soft coil spring. This shock absorber, accurately calibrated according to operator's location, size of machine and other riding characteristics, controls the rebound of the spring as jolts are absorbed.

2. A LEVEL SEAT AT ALL TIMES.

Knoedler's parallel arm action keeps the operator level —with the *extra* refinement of a *slight* angle change as the seat descends in order to provide correct, comfortable thigh support. Undesirable tilting or "dumping" action is eliminated.

3. ADJUSTABLE TO WEIGHT AND CONDITIONS—INSTANTLY!

Knoedler's great exclusive is the spring and hydraulic shock absorber built as a *single unit* to allow instant adjustment of *both* to operator weight, field conditions, type of work and tractor speed.

Dealers: Write for prices and new order guide showing over 30 Knoedler seat models and how they fit more than 100 different tractor makes and models.

Manufacturers: One of our many successful designs, or a new one can put glide in the ride of YOUR equipment. It's worth looking into. Call or write. Our "flying" engineers can be in your office the same day you phone Streator 4131.

PUTTING G-L-I-D-E IN THE RIDE FOR AGRICULTURE AND INDUSTRY

Knoedler

KNOEDLER HYDRAULIC SEATS ARE NOW FACTORY-INSTALLED ON: ALLIS-CHALMERS motor scrapers, BROS compaction rollers, CLARK straddle lift carriers, COCKSHUTT tractors, DEMPSTER loaders, DOMINION road graders, FIELD QUEEN forage harvesters, FOUR-WHEEL-DRIVE skidders, GARDNER-DENVER material handlers, GLEDHILL highway markers, GROVE cranes, H & E windrowers, H & G "Landmasters", HAHN sprayers, HERCULES POWDER CO. (gov't. equip't.), HUBER-WARCO road graders, HYMAN FREEDMAN cushions, KROMER sprayers, MINNEAPOLIS-MOLINE farm tractors, OWATONNA windrowers, PETTIBONE-MULLIKEN loaders, SEAMAN-ANDWALL rollers, SHEPPARD DIESEL tractors, WESTINGHOUSE-LE ROI tractors.

KNOEDLER MANUFACTURERS, INC. • Div. 80 • Streator, Ill.

AGRICULTURAL ENGINEERING

VOL. 37 APRIL, 1956 No. 4

Controls for Full-Leveling Hillside Combine

S. D. Pool

Following development of the side-leveling hillside combine, it was necessary only to add steerable wheels, which raised and lowered, and to include a link connection for maintaining height of the header above the ground, in order to provide a full-leveling combine. However, to attain this objective and at the same time to perfect safe, automatic full-leveling control of the machine called for a high order of engineering skill and know-how

PULL-TYPE side-leveling combines have been used for many years, principally in the northwestern United States and in north Africa. These machines were pulled, first by horses and then by track-type tractors along the hillside contours. They leveled side to side over 30 deg with the header extended uphill and about 15 deg with the header downhill. When available, fore-and-aft leveling of the self-contained cleaning unit was limited to about a 10 deg up and 10 deg down leveling of the grain-cleaning chaffer and shoe sieves. There was no attempt of a fore-and-aft leveling of the straw-cleaning mechanisms.

The advent of the self-propelled, front-cut combines to the prairie grain fields and to any flat field tucked into the hills brought an insistent farmer demand for self-propelled, leveling front-cut combines for hillside work, and to local inventors belongs the credit for solving the engineering problems involved in maintaining a steady feed from a front-mounted cutting platform, kept parallel with the ground, to a separator maintained in a level position.

The Harris Company of Stockton, Calif., was the first to produce factory-built, self-propelled, front-cut combines in fair quantity. The shops of Dave Neal at Garfield, Wash., the Hutton Brothers at Edwall, Wash., and Frank Farber at Moscow, Ida., also turned out self-propelled, front-cut "side levelers." Some of these units were made by adding side-leveling and platform-leveling features to commercial self-propelled combines, and some units were made by adding self-propelled and front-cut platform features to pull-type hillside combines.

The John Deere Company and the J. I. Case Company later provided improved factory-built versions of the local designs.

These hillside combines are all side levelers, built to level as the combine is driven on the contour. Only the Harris machines and a few of the conversions have the addition of a leveling cleaning shoe to provide some measure of grain saving when proceeding uphill or downhill.

The following drawbacks of the side-leveling combines influenced the International Company to consider developing a full-leveling hillside combine:

- Some fields cannot be cut satisfactorily on the contour side-leveling combines. When hillside farmers are tempted to cut in lands in the same manner as the prairie farmers harvest their fields, a great deal of grain is lost out of the rear of the combine.
- In hill climbing, the fore-and-aft shift in the center of gravity decreases the weight on (and therefore the traction of) the drive wheels, and increases the weight on and the drag of the steering wheels, thereby limiting the ability of the side-leveling machine to climbing straight uphill.
- In driving straight downhill, the fore-and-aft gravity shift may decrease the weight on the steering wheels to the point where steering-wheel control is ineffectual.
- A fore-and-aft shift of the center of gravity adds to the danger of the driver taking one chance too many and rolling the combine off the hill.

Our company made a contract with Frank Farber of Moscow, Ida., under which he rebuilt grain combines into a pilot model group of full-leveling combines, using in general the features of his own conversion designs but including a fore-and-aft leveling feature.

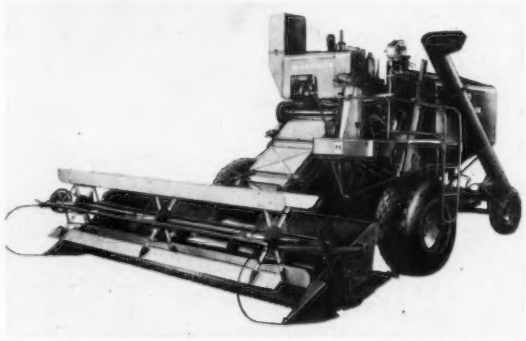


Fig. 1 This International Harvester self-propelled hillside combine is full-leveling, that is, both from side to side and from front to rear

The development of the full-leveling combine required only two elements not found in the side-leveling combines. These were *(a)* steerable wheels which raised and lowered with relation to the combine and *(b)* link connection from the steerable wheels to the header so that the header height above the ground would not change regardless of fore-and-aft leveling

The provision of fore-and-aft leveling did not prove difficult, and the resulting full-leveling combine seemed to

Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1955, on a program arranged by the Power and Machinery Division.

The author—S. D. POOL — is chief engineer, product engineering department, East Moline Works, International Harvester Company.

be a better hill climber and grain saver than the side levelers.

The combine leveled 16 deg to either side, 18 deg climbing, and 6 deg going downhill, and, of course, it operated on hills far beyond its leveling capacity. The center of gravity was well controlled while climbing, but the limited leveling, possible going downhill (before the combine drags bottom), does not put very much more weight on the steering wheels than the side levelers have.

Sharp slopes which can be climbed safely may not be descended safely, and, of course, the combine saves grain going uphill that it would ultimately lose out the back end going downhill.

The inferior operation when cutting downgrade is matched by the difficulty of getting grain into the feeder platform, and therefore steep grades are generally cut on the contour or while going up.

It is interesting to note that the self-propelled, front-cut combines level side to side about 12 deg less than the maximum side leveling of the old pull-type combines, but in general the self-propelled combines level satisfactorily.

The fore-and-aft leveling was satisfactory during first trials, but the leveling control required long, drawn out engineering consideration.

As the so-called two-way leveling was at least twice as complicated as side leveling only, a considerable study was made of the leveling control problem.

Our experimental work convinced us that the multiple operations required of a single operator on a hillside combine cannot include safely the manual operation of hydraulic valves for both fore-and-aft and crosswise leveling. The combine operator is overburdened already with combine controls, and to maintain the center of gravity when turning in a gully is a difficult operation, even for an experienced operator.

For safety considerations a fast response to leveling was found to be necessary for swinging on turns and crossing ridges and swales. At the same time a too-fast response jars the operator and gives him a pitching ride. A leveling speed of 3.5-deg per sec crosswise and 2.3 deg per sec fore-and-aft keeps the combine following the land in a level position and gives a controlled ride which contributes to operator comfort and a safe feeling.

Operator comfort does not seem to require any rest periods in leveling operation while cutting in the field. Operation of the leveling mechanism may involve a continuous readjustment. However, whenever the machine is stopped, it should come to a level position and lock there, or the operator will distrust the mechanism.

The experienced operator will become annoyed if his machine level does not hold to a level position without $\pm$ 3 deg.

Originally the leveling mechanisms were not adjustable, but fore-and-aft and cross adjustments were added after it was found that some operators were consistently off on their level perception and would not feel level until they had readjusted the leveling mechanism to a slight angle. Also, many operators wanted to carry the tail of the combine high.

Both safety considerations and operator comfort require a completely dampened system in which no beat or oscillation can be induced in the leveling combine unit. In addition, the dampening system for the fore-and-aft leveling should control any pitch due to pendulum swing induced by sudden brake application.

Fig. 2 A heavy pendulum, suspended in an oil bath, responded to even the slightest grade changes to open and close hydraulic valves for precision leveling

The leveling system should be easy to service and adjust. For shipping abroad it should be easy to ship also. If possible, the use of limit switches which require adjustment should be avoided.

Safety and service considerations both required an overcontrol of the leveling system available to the operator at all times.

Safety considerations required either locks or slow-fall controls on the hydraulic-leveling control cylinders to avoid a rapid collapse in case of hydraulic line failure. A rapid collapse of the leveling system is dangerous because of the rapid shift in center of gravity and because of the tendency

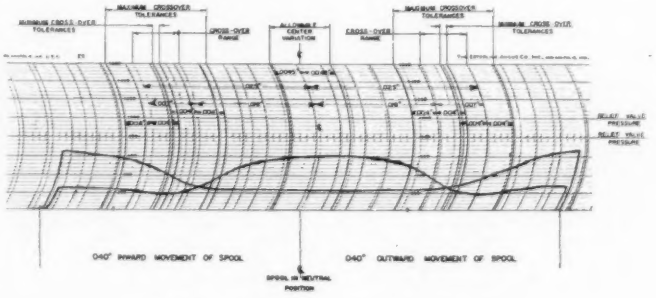


Fig. 3 Hydraulic valve test crossover chart

of the machine to bounce after collapse—a bounce which might roll it down the mountain.

None of the various types of automatic leveling controls for side-leveling, developed in the Pacific Northwest, were considered satisfactory for full-leveling control.

The hydraulic automatic leveling controls available were divided into two types: hydraulic valves actuated directly by a heavy pendulum, and hydraulic valves actuated by a servo system controlled by a small pendulum or liquid level. Both types worked and both types had drawbacks.

The servo systems were relatively complicated systems, usually involving solenoid control valves and limit switches. As only 6-volt, or at most 12-volt, current was available for solenoid operation, solenoid power was limited and a speck of dirt in the hydraulic system might jam the valve and render the system inoperative.

The direct-actuated valves were insensitive and erratic in operation and even more subject to overrun and overcontrol than the servo systems. With both types of control the stability of control was a problem. Any natural frequency of the combine control system might be aggravated by crossing listed land at an angle causing a sway and an overcontrol rock induced in the combine which might build up to harmful proportions. The vibration-dampening devices used with either system were helpful but tended to reduce the sensitivity of the leveling.

The direct-acting valve and pendulum system was attractive because such a system could be placed so that the operator could overcontrol the pendulum at any time—with sufficient force to break loose a stuck valve. Also, such a system seemed to require the fewest parts and to be the simplest to service. Therefore, it was decided to try to improve on the direct-acting control system.

One pump with a capacity of 13.5 gpm at 2200 rpm was used for the leveling valves. The valves were used in series; first, the cross-leveling valve with by-pass at 1000 psi, and then the fore-and-aft-leveling valve, with by-pass set at 750 psi. At those pressures both valves could act at the same time without blowing their respective by-pass valves.

By-pass valves were provided also in the hydraulic cylinder heads to open at stroke end to avoid the necessity for travel-limit switches. On a slope beyond the leveling ability of the combine, the control valve would remain thrown and the hydraulic circuit would be through the leveling cylinder piston and return.

Such a system, mocked up, with a pendulum rod acting directly on two commercial, four-way, open-center, series-connected spool valves set at 90 deg (one crossways for side-leveling control and the other for fore-and-aft-leveling control) gave leveling accurate to $\pm 12\frac{1}{2}$ deg. It was necessary to reduce that $\pm 12\frac{1}{2}$ deg variation to ± 2 deg.

To make a more sensitive valve, the drag of the seal on the valve spool was reduced by using only a wiping-lip seal, faced lip out. Drag was reduced further by maintaining a bath of 0 deg pressure oil behind the lip seal, (spool leakage separately connected to a drain-to-tank line), and allowing a modest leakage past the seal.

Valve sensitivity (in these series-connected, open- center valves) was affected significantly by line back pressure and the valve port and land combinations were altered to give an absolutely symmetrical valve design. After that change, line back pressure or cylinder pressure did not affect the ease of spool movement.

Further experiment resulted in increasing the spool and valve clearance to give a controlled leakage past the spool ends of 0.03 to 0.05 gpm at 1000 psi pressure. The controlled leakage was bled back from the ends of the spool to the hydraulic tank, and was insufficient in quantity to affect operation of the hydraulic system. However, the leakage was sufficient to float the spool and allow easy operation at all times.

The light-lip-seal, symmetrical-valve construction, and controlled leakage floating the valve spool reduced the pull required to operate the valve. The value remained practically constant regardless of line back pressure or cylinder operating pressure.

To center the spool under so light a drag required only a nominal centering spring. However, the spring would not close the valve when operated in conjunction with the leveling pendulum.

Eventually the combination worked itself out. A pendulum 36-in long from pivot to the center of gravity of a 100-lb weight with the two valves set 9 in below the pendulum pivot, and have 12-lb centering springs, was specially mounted to reduce drag. That combination provided for a come-up-to-level-and-stop response.

However, the level was still far greater than the desired ± 2 deg. To assure the quick response the valve and spool lands were recut so that each land with within ± 0.0012 in of its theoretical position, and valve throw was greatly reduced.

The accurate cutting of the valve and spool improved the leveling control of the valve to ± 2 deg under operating conditions.

Further experiment demonstrated that the total throw of the valve in either direction should be held to 1/16 in to minimize overcontrol or oscillation of the leveling mechanisms. That is, if any significant movement of the pendulum

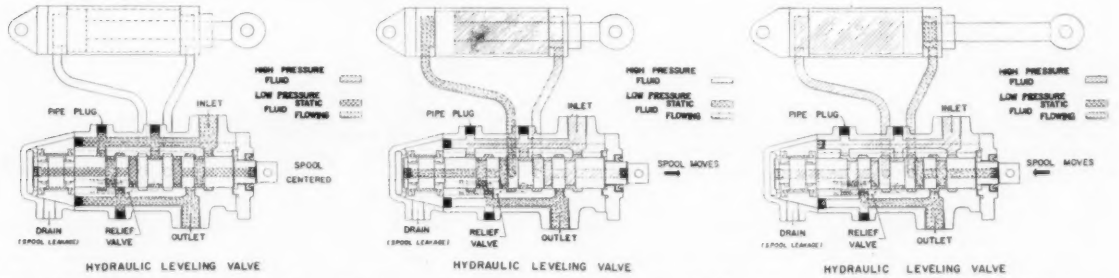


Fig. 4 Hydraulic leveling valve in three operating positions: *(Left)* spool is centered, *(Center)* spool moves to right, and *(Right)* spool moves to left

were allowed, the generated momentum would carry the pendulum through the level or open-center valve position into the reverse leveling position.

Limiting the pendulum movement to 1/16 in each way at the valve or ¾ in total movement at the pendulum reduced the cycling tendency. It was necessary to use a stiff pendulum rod to avoid pendulum overswing due to rod deflection.

The thrust of the 100-lb pendulum at a 2½ deg out-of-level angle is only 11 lb. However, the vibration of the combine, when harvesting, will induce a small movement of the pendulum, giving a live leveling action in which pendulum inertia moves the valve. Also, on stopping, the combine will come close to theoretical level due to the pendulum hanging back, so that the combine will be full level before the valves close.

The specifications of the valve as written were as follows:

- An open-center (series) type, four-way, spool-type, hydraulic valve for 1800 psi pressure maximum and 13.5 gpm flow with completely symmetrical design, and throw limited to 1/16 in in either direction.
- Controlled leakage to ends of spool of 0.03 to 0.05 gpm at 1000 psi pressure, with ends connected and provided for bleed-back to tank.
- Centering springs of 12 lb accurate to ±½ lb in working length, and specially mounted to reduce friction drag.
- Open center of 0.036 in.
- All ports open position (to assure no surge, hammer, or line cut-off in operation) of 0.007 in between open center and operating positions, with complete pressure build-up to operating pressure in 0.004 in.
- Valve full on in 0.025-in movement from center.
- Spool seal lip out and seal drag limited to 5 lb when oiled by bleed-back spool leakage at 0-in head. Valve to throw in either direction under 17-lb thrust.
- The required accuracy of ±0.0012 land location in the valve body required milling all six grooves at one time, and the spool diameter was therefore made 1¼ in to allow the insertion of a good sized special milling cutter into the valve. (This 1¼-in spool diameter provided a length of 3.9 in for pressure drop control. That length proved to give a pressure build-up in about 0.004 in of valve movement).

By cutting six grooves in the valve body at one time, the vibration of the milling cutter was excessive when driven from one end. It was necessary to design a small milling machine in which the cutter was driven and positioned from both ends, before milling of the valve body was entirely satisfactory.

An interested vendor contracted to supply the complete valves, providing that the valve bodies were milled on the special milling machine, and satisfactory valves were produced in that manner.

The operation of the leveling valves gave little trouble, but the design of the pendulum dampener was revised several times because the machines as originally built were tight and did not develop oscillating vibrations easily. The more usage the combine receives, the looser its joints become, and the easier it rocks or oscillates. Therefore, dampeners, at first satisfactory, were later unsatisfactory.

Several types of dampeners were designed, first, by Mr. Farber and then by International Harvester Co. combine engineers. The problem was made more difficult by the small (¾-in) movement of the lower end of the pendulum and by the necessity of not reducing the sensitivity of the control valves.

The eventually successful solution was to use an oil bath dampener consisting of two $2^{31}/_{32}$-in diam disks sliding in a 3-in. inside-diameter cylinder (one cylinder for fore-and-aft and one for crosswise leveling). The disks are driven by a stud on the lower end of the pendulum weight which engages a slotted-drive member joining the disks.

The disks are large enough to move considerable oil with very little movement, and the disk clearances are such that the sensitivity of the pendulum is not impaired greatly.

The viscosity of the oil may be adapted to the requirements of the machine and weather.

American Irrigation Pumps and Irrigation Engineer Provide Lift for Philippines Agriculture

Since 75 percent of the workers on the 7,100 islands of the Philippines archipelago are in agriculture or related work, it can be readily understood that a major prop in the economy of the Islands, whose population totals 22 million people, lies in the advancement of the country's agriculture from its present somewhat primitive status. Lending assistance to this effort, the International Cooperation Administration has set aside funds, matched by the Philippines government, for the purchase of 115 irrigation pumps to supply water for the irrigation of 28,000 hectares (approximately 70,000 acres) of land to benefit close to 10,000 families.

The American irrigation engineer representing ICA on this project is William D. M. Reeves (Member ASAE), who will advise Philippine government agencies in planning, installation, and operation of the irrigation equipment, also in the long-term planning for the collection of hydrologic data for future development. Pictured above *(left)* is the discharge of one of the large newly installed pumps into an irrigation ditch. In the other picture *(right)* is shown a Philippines irrigated rice field, one of the thousands included in the Philippines-ICA-sponsored project.

Energy Losses at Draintile Junctions

P. W. Manson and F. W. Blaisdell
Member ASAE Member ASAE

ACTUAL energy loss at a tile junction has long been a major unanswered question in the design of a tile drainage system. In order to make an investigation under simulated conditions, a laboratory study was set up in the St. Anthony Falls Hydraulic Laboratory at the University of Minnesota, to determine junction energy losses when the lateral is the same diameter as the main. The entry angles were 15, 30, 45, 60, 75, 90, 105, 120, 135, 150, and 165 deg. The velocity of the flow in the lateral and the main ranged from 2 to 15 fps. The pipes were flowing full at all times. The data show that a 90-deg junction will give as satisfactory results for agricultural drainage systems as the more commonly recommended 45-deg junction. This is because the junction energy losses are so small for the usual drainage tile installation.

Laboratory equipment substitutes for actual field conditions as results indicate no significant advantage from a practical standpoint between a 45- and a 90-degree junction angle in agricultural tile drainage systems

Previous Work

A search of the literature reveals little information on the energy losses at joining pipes. This is particularly surprising when the important application to such fields as oil, water, and sewerage collection and distribution systems, as well as to agricultural drainage systems, is realized.

Naramoto and Kasai (1)* made a study of joining pipes, but in such a way that the data do not cover the complete range of possible flows. Naramoto and Kasai's tests yield only limited information of practical value for the conditions covered by this progress report. Vogel (2) has reported tests on 90-deg junctions, Petermann (3) has tested 45-deg junctions, while Kinne (4) has extended this to 60-deg junctions, these tests being performed at Munich. Apparently the only work done in the United States is that reported by McNown (5).

Experimental Apparatus

The experiments were conducted with an especially designed piece of laboratory equipment. A centrifugal pump took water from a reservoir and forced the water through supply lines to the upstream ends of both the lateral and the upstream main. Valves in the supply lines were adjusted to regulate the rate of flow in the lateral and the upstream main. The rate of flow was measured by calibrated elbow meters. The water was turned 180 deg at the upstream ends of the lateral and the upstream main and carried down these pipes to the junction. The 90-deg junction is shown in Fig. 1. At the junction the flow from the upstream main and the lateral were combined, carried through the downstream main, past a third elbow meter, and returned to the supply reservoir.

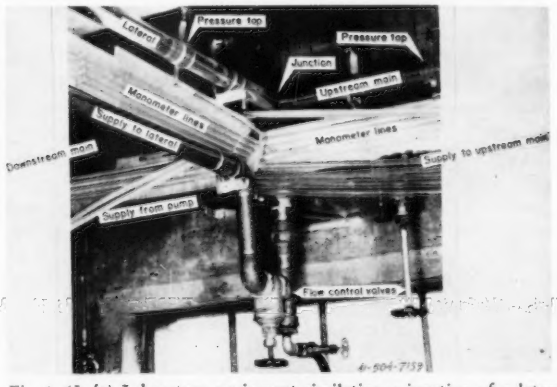
The pipe lines were simulated by 2-in inside-diameter transparent plastic pipe (Fig. 1). The junctions were machined from the same type material. The arrangement of the apparatus was such that junction angles ranging from 15 to 165 deg could be installed readily.

The downstream main, the lateral, and the upstream main were each 20 ft 10 in long. Five pressure taps were located in each of the three lines at distances of 20, 70, 120, 170, and 220 in (10, 35, 60, 85, and 110 pipe diameters, respectively) from the junction. Lines from each of these pressure taps were connected to the manometers shown in Fig. 2. The levels of the liquids in the manometers were

Paper prepared expressly for AGRICULTURAL ENGINEERING. A progress report based on a cooperative undertaking of the eastern soil and water management and watershed hydrology sections (SWCRB, ARS), U.S. Department of Agriculture, the department of agricultural engineering and the St. Anthony Falls hydraulic laboratory of the University of Minnesota, division of waters of the Minnesota Department of Conservation, and American Concrete Agricultural Pipe Assn. Approved for publication as Scientific Journal Series Paper No. 3423, Minnesota Agricultural Experiment Station.

The authors—P. W. MANSON and F. W. BLAISDELL—are, respectively, professor of agricultural engineering, University of Minnesota, and USDA collaborator, and project supervisor, watershed hydrology section (SWCRB, ARS), U.S. Department of Agriculture.

*Numbers in parentheses refer to the appended references.



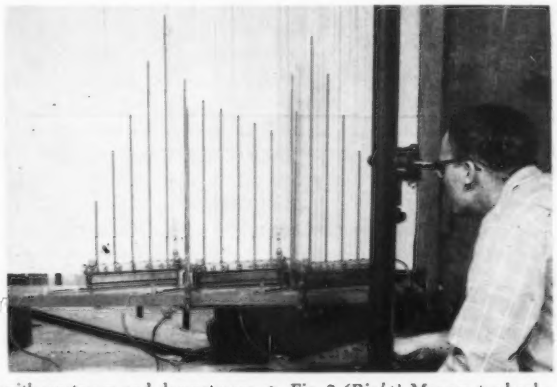


Fig. 1 *(Left)* Laboratory equipment similating a junction of a lateral with upstream and downstream • Fig. 2 *(Right)* Manometer banks, from left to right, represent the downstream main, the lateral or branch, and the upstream main

read with a cathetometer—a level moving vertically on a scale read to 0.05 mm. The manometer banks in Fig. 2 represent, from left to right, the downstream main, the lateral or branch, and the upstream main.

Experimental Procedure

The tests were conducted by adjusting the flow in the lateral and the upstream main to the desired rate. The manometers were then read to obtain the pressures in the various lines. Innumerable important details required constant alertness, such as making sure there was no air in the many manometer lines or that the cooling-water feed was just sufficient to compensate for the pump heating.

Several velocities in the downstream main were tested. Ordinarily these velocities were 2, 5, 10 and 15 fps. Eleven runs were made at each velocity, each run having a different ratio of discharge in the lateral or branch Q_b to the combined or total flow in the downstream main Q_d. For the first test the entire flow might be in the upstream main ($Q_b/Q_d=0$). The second test might have 10 percent of the flow entering the lateral ($Q_b/Q_d=0.1$). The flow in the lateral was then increased by 10 percent increments until all the flow entered from the lateral ($Q_b/Q_d=1.0$). Usually there were 44 runs made for each junction angle, although duplicate tests with different observers were made for several junctions early in the test program. Over 600 tests were made with the lateral the same size as the main.

Experimental Analysis

The basic data for the analysis consisted of the rate of flow in each of the three lines and the elevations of the fluid in each of the 15 grade-line manometers. The following computation was required to develop the junction-energy loss from these basic data.

Most of this computation involved the data obtained from the manometers shown in Fig. 2. A line through the top of the fluid columns in each manometer bank represents, from left to right, the hydraulic grade line in the downstream main, the lateral, and the upstream main, respectively. The projection of these hydraulic grade lines to the junction provides a means of correcting for the friction in each pipe and, after velocity head differences are accounted for, permits the separation of the pipe friction loss from the junction energy loss.

A more detailed explanation of the grade-line manometers and their operation can be facilitated by referring to Fig. 3.

The main is shown but the branch location is indicated only. The subscript $_d$ refers to the downstream main (to the left) and the subscript $_u$ to the upstream main (to the right). The diagram and the analysis will apply to the lateral or branch if the subscript $_b$ is substituted for the subscript $_u$.

The five pressure taps in each of the three lines are connected to a bank of five manometers immersed in a single pot of manometer fluid. Carbon tetrachloride, Meriam No. 3 fluid, and mercury were used in the pots. The manometer fluid densities are designated by γ. The pots were covered and sealed. The pressure difference between the pots was measured by a U-tube manometer. In operation, the center manometer in each bank is brought to a set elevation by admitting water under pressure to the pots. The elevation of this center manometer is maintained at the chosen elevation throughout the tests. This is in order to keep the same

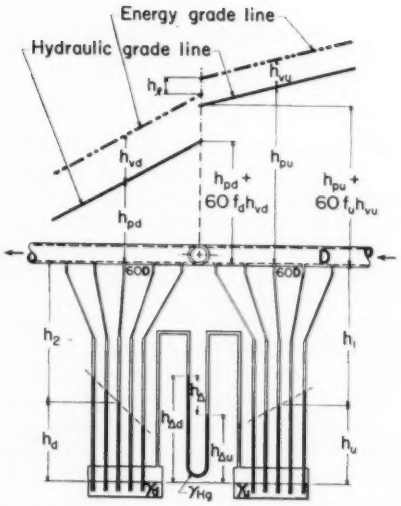


Fig. 3 Determination of the junction energy loss from the grade-line manometer readings

volume of liquid in the pot at all times and make corrections for varying pot levels unnecessary.

If the same liquids are used in each pot, the difference in pressure indicated by the U-tube manometer indicates the approximate drop in pressure between a point 60 pipe diameters upstream from the junction to a point 60 pipe diameters downstream from the junction. Included in this pressure drop is the friction in the two pipes, a difference in velocity head due to the combining of the two flows at the junction, and the junction energy loss that is to be determined.

The diagram above the pipe in Fig. 3 shows how these losses are separated. The hydraulic grade line can be plotted from the manometer readings. The slope of the hydraulic grade line is indicative of the rate of friction loss. The energy grade line is plotted above the hydraulic grade line a distance corresponding to the velocity head in the respective pipes. The greater velocity head for the downstream main is because of the additional flow in the downstream pipe due to the added flow from the branch. When the energy grade lines are projected to the junction they do not meet. The difference between them, h_l, represents the energy head loss at the junction. This is the answer—the loss at the junction, separated from the friction in the pipes and the differences in velocity head.

The final step in the analysis is to divide the actual junction-energy head loss h_l by the velocity head in the downstream main h_{dv} to obtain a dimensionless junction-loss coefficient ζ. This coefficient has the same value for all velocities if the geometric and flow conditions are similar. Thus, except for inherent experimental variations, the same junction-energy head loss coefficient curve should be obtained for each velocity tested. Also this same junction-energy loss coefficient curve can be used to compute the head loss at other velocities encountered in the field no matter what the pipe diameter might be.

Scope

Tests have been completed on pipes flowing completely full where a lateral the same size as the main enters the

main at angles of 15, 30, 45, 60, 75, 90, 105, 120, 135, 150, and 165 deg. The junction was sharp-edged in each case. The loss in energy caused by flow entering at the junction has been determined for both the lateral and main. The data are limited to turbulent flow in the pipes, the usual case encountered in practice.

Results

The energy-loss coefficients ζ for each junction angle were plotted against the ratio Q_b/Q_d of the flow in the branch Q_b to the flow in the downstream main Q_d for both the lateral and the upstream main. A smooth curve was drawn through the data points. The curves for all entry angles have been combined into single plots for the lateral and for the upstream main and are presented in Fig. 4. These curves represent the actual data from some 600 tests. Later these curves may be adjusted slightly to represent a smooth family of curves.

Comparison with Previous Work

In Fig. 5 a comparison is made of the data obtained by the authors and presented in Fig. 4 with all available data obtained by others. The agreement is satisfactory for similar conditions. Agreement with the data presented by McNown does not correlate as well at the higher values of Q_b/Q_d.

Use of Curves

To use these curves, the ratio Q_b/Q_d of the flow in the lateral Q_b to the combined flow in the main downstream from the junction Q_d is determined. The corresponding loss coefficient ζ is read from the curves for the pertinent entry angle; ζ is then multiplied by the velocity head of the combined flow in the main downstream from the junction $V_d^2/2g$, to obtain the actual loss in energy head due to the flow from the junction.

Example

A section at the upstream end of a farm tile drainage system will be computed to illustrate the use of these curves. The example is necessarily limited to that part of the drainage system where both the lateral and the main are the same size, since junctions have not been tested using laterals of other sizes. It is assumed that:

- The minimum tile size is 6 in.
- The slope of the main is 0.1 ft per 100 ft.
- The Manning roughness coefficient is 0.011.
- The drainage coefficient is $\frac{3}{8}$ in per day.
- The area tributary to each lateral is 3 acres, giving a flow of 0.05 cfs from each lateral.
- The laterals join the main at 100-ft intervals.

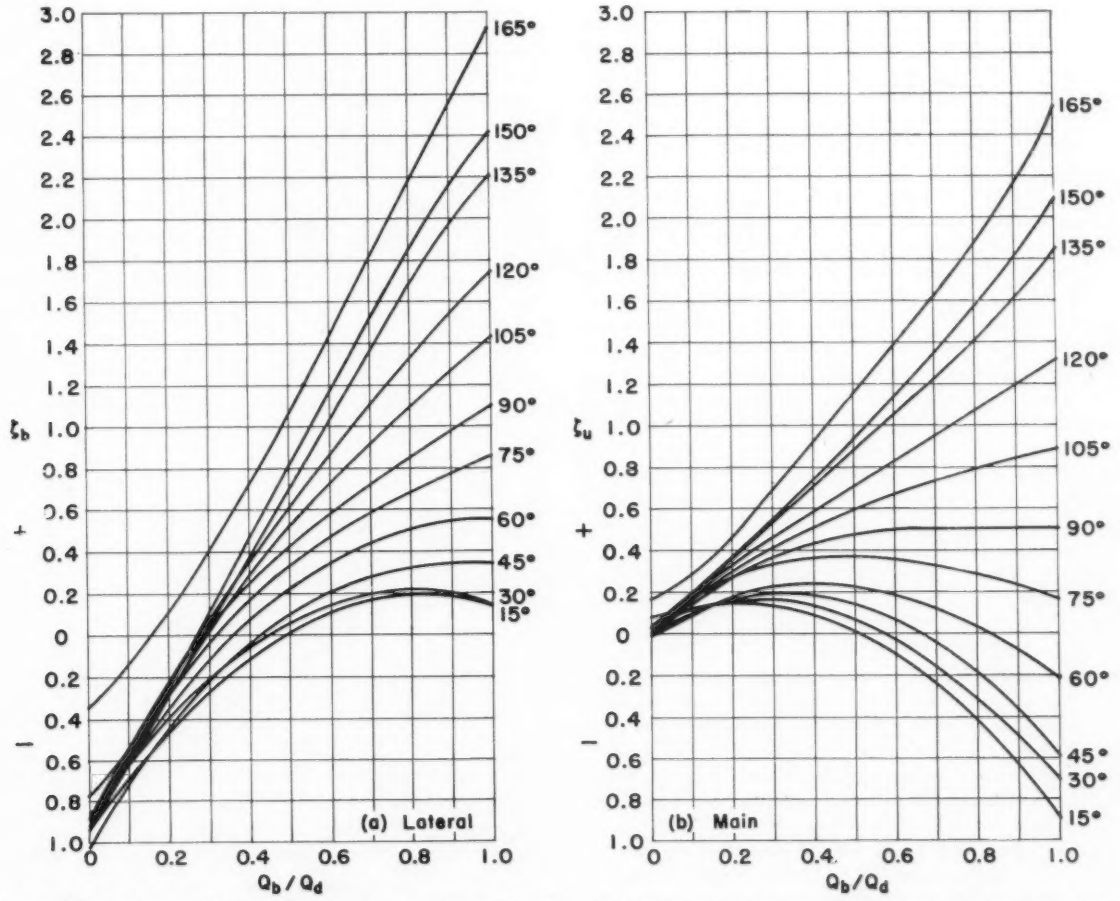


Fig. 4 Junction-loss coefficient for joining streams: *(a)* lateral, *(b)* main. The lateral is the same size as the main, the junction is sharp-edged, and both the lateral and the main are completely full.

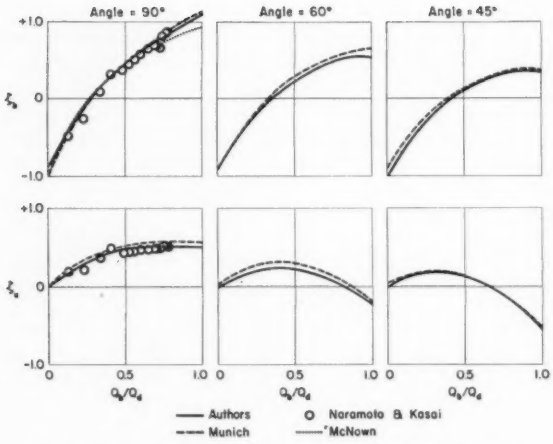


Fig. 5 Comparison of results with those obtained by others

- The laterals join the main at right (90-deg) angles.
- The lateral and the main are completely full at the junction. (Since the main is full, water will back into and completely fill the lateral for a short distance.)
- The amount of water entering the main through the joints is so small that it can be neglected.

The first step is to determine the flow in each section of the system. The sketch (Fig. 6) shows that 0.05 cfs enters the main from each lateral and that the flow below each lateral is the sum of the flows from each lateral entering upstream from the point in question. In the table below Fig. 6, figures applying to the main between the junctions are entered in columns midway between the junction points, while figures applying to the junction are entered in the columns directly below the junction points.

The ratio Q_b/Q_d of the flow from the branch to the flow in the main downstream from the branch is computed next and entered in the table. Values of ζ_u for the main are read from the curves (b, Fig. 4) for a 90-deg angle. The velocity in the main downstream from each junction is computed from the equation $V_d=Q_d/A$ or, in this case, $V_d=Q_d/0.196$, while the corresponding velocity head is computed from the relationship $V_d^2/2g=V_d^2/64.4$. These values are entered in the table. Here Q_d is the discharge in cubic feet per second, V_d is the velocity in feet per second, and A is the area of the pipe in square feet, all quantities being measured downstream from the respective junction. The final step in determining the actual loss at the junction is to multiply the velocity head downstream from each junction by ζ_u to obtain the actual loss in head in the main at each junction.

By adding the losses in this example for all five 90-deg junctions gives a total loss of only 0.018 ft, or less than ¼ in. The corresponding total loss for the five laterals which join the main at an angle of 45 deg is 0.009 ft, or about ⅛ in. The energy loss in the bend that connects the lateral to the main when a 45-deg junction is used is assumed to be negligible. There is therefore a difference in favor of the 45-deg junction of only ⅛ in per 500 ft—an obviously insignificant amount. When 90-deg junctions are used instead of 45-deg junctions, it is necessary to increase the slope of the main by only 0.02 in per 100 ft to compensate for the increased junction loss.

If the slope of the main had been 1 ft per 100 ft, it would be possible to drain an entire 40 acres with a 6-in main. (Drainage coefficient = ⅜ in). The total junction losses in this case would be 0.120 ft for thirteen, 90-deg junctions and 0.081 ft for thirteen, 45-deg junctions. The difference of 0.039 ft (about ½ in), in favor of the 45-deg junction is still so small as to be negligible from the standpoint of field installation. Again the required increase in the slope of the main amounts to only 0.02 in per 100 ft to maintain the same flow for 90-deg junctions as for 45-deg junctions.

These tests show that, for a lateral the same size as the main, the 90-deg junction is almost as satisfactory hydraulically as a 45-deg junction; the difference in the losses between a 45-deg junction and a 90-deg junction is unimportant in the design of an agricultural drainage system.

The friction loss h_f in the main between junctions is computed by rearranging the Manning formula

$$Q=\frac{1.486}{n}A\,r^{2/3}\,s^{1/2}$$

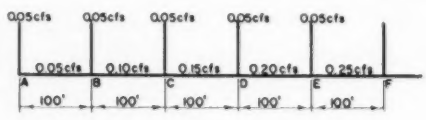
to read, substituting for r its equivalent for a circular pipe, $d/4$,

$$h_f=sl=l(4/d)^{4/3}\,(Qn/1.486A)^2$$

where Q is the discharge (cfs), n is the Manning roughness coefficient, A is the area of the pipe (sq ft), r is the hydraulic radius (ft), s is the slope of the pipe, d is the diameter of the pipe (feet), and l is the length of the pipe (feet). For this example, $l=100$ ft, $d=0.5$ ft, A$=0.196$ sq ft, $n=0.011$, and $h_f=2.28\,Q^2$. Values of h_f are listed in the table (Fig. 6).

The hydraulic grade line can now be plotted. In this particular example, the initial point must be assumed, since the remainder of the system has not been designed. The initial point will be taken at the crown of the pipe where it enters the next larger section of the main. The hydraulic

(Continued on page 257)



Junction	A	B	C	D	E	F
Pipe		A-B	B-C	C-D	D-E	E-F
Q		0.05	0.10	0.15	0.20	0.25
Q_b/Q_d	1.00	0.50	0.33	0.25	0.20	
ζ_u	0.51	0.48	0.38	0.32	0.27	
V_d		0.26	0.51	0.76	1.02	1.27
$V_d^2/2g$		0.001	0.004	0.009	0.016	0.025
h_b	0.001	0.002	0.003	0.005	0.007	
h_f		0.006	0.023	0.052	0.092	0.143

Fig. 6 Sketch and table of data for a typical tile drainage system where both the lateral and the main are the same size

Human Tolerance to Vibrations in Farm Machines

Max Haack

Strains resulting from the vibration of farm machines driven over rough ground may exceed the limit of human tolerance. One-fourth of all human beings are more sensitive to vibration than the norm from which the limit was established. These persons can suffer physical impairment while driving tractors, which because of a combination of slow speed and inadequate seat suspensions originate severe exciting forces. Spring mounting of all masses in such manner that natural frequency is less than two cycles per second may be the only satisfying solution.

IN FARM work, the fatigue and discomfort to which human beings are subjected is due not only to physical labor, but to vibrations as well. These vibrations arise either from vehicles traveling over rough surfaces or from unbalance of moving parts of machinery.

Vibrations represent the phenomenon of non-harmonic oscillation which, according to the Fourier analysis, may be resolved into a single basic oscillation with one or more harmonics of higher frequency. The human tolerance to oscillation is a measure for evaluating vibrations. This, however, requires that human susceptibility be expressed in exact figures.

Human Susceptibility to Oscillation

Human susceptibility may depend upon different characteristics of oscillation, for instance, amplitude, speed, acceleration and/or the rate of change of acceleration (jerk). Sufficient information has been collected as the result of extensive investigations conducted during the past 30 years to permit a rather accurate evaluation of human susceptibility. For instance, Den Hartog (1)* concluded, as the result of a theoretical investigation, that the rate of change of acceleration must be a general measure for the intensity of sensations of oscillation. Reiher and Meister (2, 3), on the other hand, determined experimentally that at frequencies between 2 and 10 cps (cycles per second), with an amplitude of only a few millimeters, the intensity of sensation is directly proportional to acceleration.

In several more recent papers, however, the frequency range from 1 to 60 or 1 to 80 cps is divided into three sections, each associated with a quite different principle. Janeway (4, 5) differentiates:

- Low-frequency range, from 1 to 6 cps. Within this range, the intensity of sensation is proportional to "jerk" (rate of change of acceleration), with a maximum allowable limit of 480 in per sec^3, expressed mathematically as
$$af^3 \approx 2$$
- Medium-frequency range, from 6 to 20 cps. Within this range, intensity of sensation is proportional to acceleration, with a maximum allowable limit of $0.033g$ (g=acceleration due to gravity), expressed mathematically as
$$af^2 \approx 1/3$$
- High-frequency range, from 20 to 60 cps. Within this range, the intensity of sensation is proportional to the velocity of oscillation, with a maximum allowable limit of 0.105 in per sec, expressed mathematically as
$$af \approx 1/60$$

In the formulas above, f represents frequency in cycles per second and a the amplitude in inches. Results published by Goldman (5, 6) based on biological investigations closely agree with data given by Janeway.

One of the recent papers presented in Germany by Zeller (7) needs to be mentioned. His summaries, which are based on tests conducted by Postlethwaite (9), Meister (2, 3), and Békésy (10, 11) are shown in Fig. 1. Zeller has originated a scale which relates the intensity of sensation of oscillation to both accelerations and frequencies, based on the experience of the above-mentioned investigators. With the aid of these investigations, Zeller establishes the following scale (in pal)† for the intensity of sensations of oscillation:

0-10 Sensations depending on the position of the human body

10-20 General sensation

20-30 Vibrations of buildings caused by heavy traffic, which are above the comfort limit for persons in such buildings

†Translators' note: W. Zeller (8) proposes a unit for the intensity of sensation of vibrations. This unit dimension is called "pal," derived from the Greek word meaning "to shake." The nature of this unit dimension is analogous to "phon" as used in acoustics.

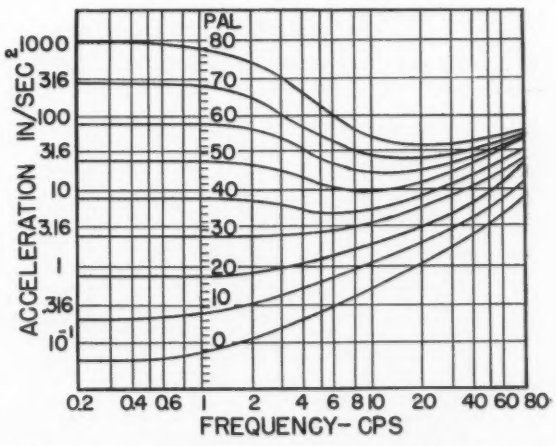


Fig. 1 Curves of equal intensity of sensations of vibrations in relation to frequency and acceleration — Zeller (7 and 8)

Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1955, on a program arranged by the Power and Machinery Division.

The author — MAX HAACK — was formerly a member of the staff of the Institute for Tractor Research, Agricultural Research Center, Braunschweig-Volkenrode, Germany. Translation from the German by W. H. Worthington and associates, engineering research division, John Deere Waterloo Tractor Works.

*Numbers in parentheses refer to the appended references.

30-40 Vibrations in smoothly running vehicles, heavy machinery or traffic vibrations

40-50 Vibrations in vehicles, acceleration of elevators

50-60 Tolerable by human beings without physical damage for a short time only, heavy vibrations in vehicles

60-80 Physical breakdown for human beings, seasickness, pain upon contact with members oscillating at high frequency.

The above scale establishes a connection between acceleration and human susceptibility to oscillations at different frequencies.

This shows that at low frequencies (below 1 cps), the intensity of sensation is proportional to acceleration. However, in the range of frequencies from 1 to 6 cps, the intensity of sensation at large amplitudes is proportional to "jerk," (but at small amplitudes, it is proportional to the velocity of oscillation). Within the frequency range above 6 cps, the sensation at small and medium amplitudes of vibration is approximately proportional to the velocity of oscillation, but at greater amplitudes it is more proportional to the acceleration of oscillation. The boundaries between the frequency ranges are not fixed at 1, 6 and 20 cps, but move toward higher frequencies at greater amplitudes.

Maximum values for the three frequency ranges given by Zeller, which are valid for vehicles, closely agree with values given by Janeway:

		Zeller	
Frequency range	Janeway	45 pal	55 pal
Low	480 in/sec^3	473 in/sec^3	985 in/sec^3
Medium	0.033g	0.030g	0.050g
High	0.105 in/sec	0.118 in/sec	0.276 in/sec

It may be concluded therefore that in each frequency range, human susceptibility to vibration is affected by a different criterion. The susceptibility of all human beings to vibrations is not alike, as is shown in Fig. 2. It is evident here that any stated value of human susceptibility to vibration represents only the average of a statistical distribution. There will be some individuals who always suffer an intolerable feeling of vibration, when the actual vibration intensity is well below the average level of tolerance. On the other hand, there are others who can tolerate a much higher level of vibration.

The sensation of vibration, which is felt differently in the different frequency ranges, seems to have a connection with the points of resonance of the human body, which can

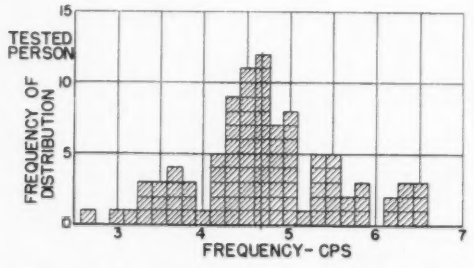


Fig. 2 Distribution of susceptibility toward vibration of male test persons in relation to the exciting-frequency of vehicle vibrations which have been experienced as bothersome to 93 male test persons within the age range of 17 and 24 years — Jacklin and Liddell (14)

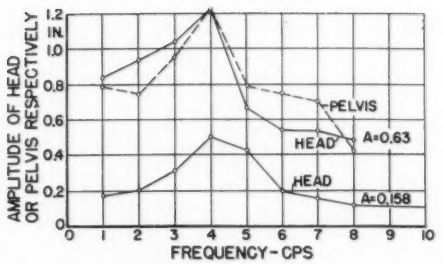


Fig. 3 The amplitude of head and pelvis as the amplitude of the seat remains constant at 0.63 in and 0.158 in, respectively —E. A. Müller (13)

be taken as a highly damped vibrational system. The natural frequency of a sitting person was determined by Wass (12) by exciting the natural oscillation (by sitting down quickly on a rigid seat). It amounts to about 6.2 cps. In a similar manner, Bèkèsy, when measuring the pressure oscillations of a sitting person transmitted to the ground (10, 11), has found a free fading oscillation of about 7 cps, which is stimulated by the heart beat. It may be concluded from his test setup that this is the natural frequency of the human body. On the other hand, Müller (13) has evaluated the greatest amplitude of a person sitting on a vibration table at a frequency of about 4 cps, as shown in Fig. 3. But even this resonance value can be reconciled with the above-mentioned natural frequency of 6 cps, if it is considered that, for instance, in the case of an oscillation with a damping factor of one-half the value of the aperiodic damping factor, the maximum amplitude will occur when the exciting frequency approximates 0.8 of the natural frequency. Thus the frequency range between 4 and 7 cps may be taken as the resonance range of the human body.

The statement made by Bèkèsy, that vibrations below 1 cps do not cause noticeable deformation of the human body, agrees entirely with the graph made by Zeller (Fig. 1; note range from 0.2 to 1 cps).

If the boundaries of tolerable accelerations for medium vibrational strain, determined by Zeller and plotted in a linear scale, are compared with the resonance curves of the acceleration of a simple vibrating system, having a

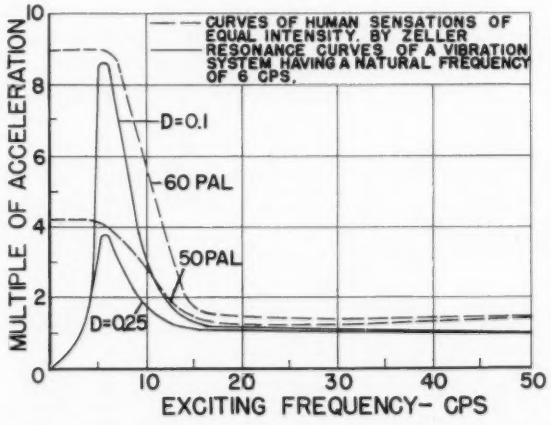


Fig. 4 Human sensations of equal intensity in comparison with resonance curves of a simple vibrator. Values by Zeller (7 and 8). D is dampening factor

natural frequency of 6 cps, a striking similarity of the trends of the curves can be seen. This is shown in Fig. 4. In this graph, the magnitude of tolerable acceleration falls off sharply at frequencies above 6 cps. Starting from 15 cps and continuing to 50 cps, it remains nearly constant. Thus the human being, with a sensitiveness to vibration of about 60 to 80 pal, can tolerate accelerations approximately six to eight times greater within the range of his natural frequency (6 cps) than at frequencies above 15 cps.

Along with his research tests, Bèkèsy investigated the transmissibility of vibrations through the human body, with results as shown in Fig. 5. According to this investigation, frequencies up to 6 cps are transmitted undiminshed through the entire body. Vibrations with freqencies above 6 cps do not reach the upper parts of the body, since such frequencies exceed the resonance range of lower body parts and are therefore filtered out. In this manner, all frequencies above 80 cps will have been absorbed before reaching the ankle of a standing person. The knee seems to be the upper limit for frequencies between 35 and 50 cps. The heart will be reached only by frequencies up to about 20 cps. According to Bèkèsy, the situation for the sitting person is not significantly changed, as the higher frequencies are then absorbed by the seat instead of the legs.

In spite of all these investigations, however, the human organs which possess susceptibility to vibration cannot be exactly located or defined. Zeller (8) assumed the equilibrium organs of the head to be the sole sensitive cell, and based on this assumption he developed his mathematical theories for defining a measure of susceptibility to vibrations. Opposed to this opinion is that of Müller, who assumed that different organs of the body are sensitive to vibration, depending upon the frequency of stimulation. Bèkèsy has a conception similar to that of Müller.

Assuming pure harmonic oscillation, there is a mathematical relationship between maximum amplitude and frequency on the one hand and maximum values of velocity, acceleration and jerk, on the other. Therefore, data are available regarding the maximum permissible amplitude in the low-frequency range of 1 to 6 cps from Jacklin, Liddell (14) and Goldmann (6) and others. Furthermore, the papers of Janeway and Zeller, previously mentioned, indicate the means for calculating the maximum permissible amplitude under conditions of pure harmonic oscillation.

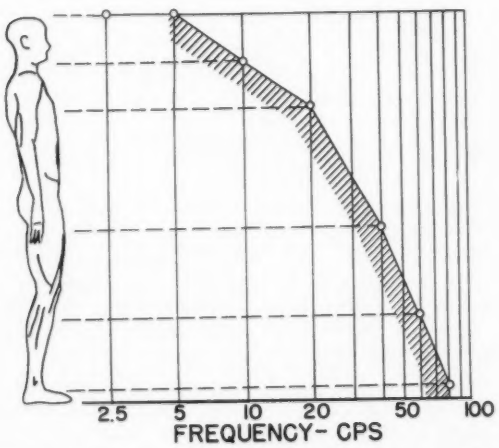


Fig. 5 Conductivity of vibrations of a standing person for different frequencies — Bèkèsy (10)

Maximum amplitude can be derived from the empirical value of 480 in per sec^3, given by Janeway for maximum permissible jerk, provided that the oscillation is purely harmonic in its nature. It can be shown that:

$$a_{max} \approx \frac{2}{f^3} \text{ inches}$$

Similarly, the following relationship may be derived from curves given by Zeller:

$$a_{max} \approx \frac{b_{max}}{100 f^2} \text{ inches}$$

Values of b can be taken from Fig. 1 for the chosen pal value of susceptibility according to frequency. According to Zeller, 55 pal has to be taken as the average value of heavy vehicle vibrations, which could be tolerated only momentarily by the human subject without injury, and 70 pal represents the heaviest vibrations, i.e., those causing physical injuries.

Fig. 6 shows maximum tolerable amplitudes based upon the investigations of Jacklin, Liddell, Janeway, Goldmann, and Zeller. The trend of the curves in Fig. 6 is quite uniform, but their range seems quiet large. These curves must be considered as representing values of human sensation of vibration which can be tolerated by most individuals. At any rate, it can be seen that at frequencies starting at 4 cps, the amplitudes which can be tolerated for any extended period of time are those with values so small that they are often exceeded in agricultural operations.

In comparing measured data, it must be mentioned that due to impacts actual vibrations frequently deviate significantly from a sinusoidal distribution. In such cases, it would be erroneous to observe only the amplitudes, since the higher harmonics present will influence the intensity of the sensations, experienced as the result of vibrations, much more severely than the basic oscillation. For this reason, measurements of acceleration best serve to give a true picture of conditions. Such determinations require measuring devices possessing a satisfactory degree of sensitivity and stability of recording, combined with light weight and a high natural frequency—a combination which at times involves some measure of compromise.

Susceptibility to Rough Road Conditions

When driving over a rough road, the principal vibrations are generally within the range of frequencies between

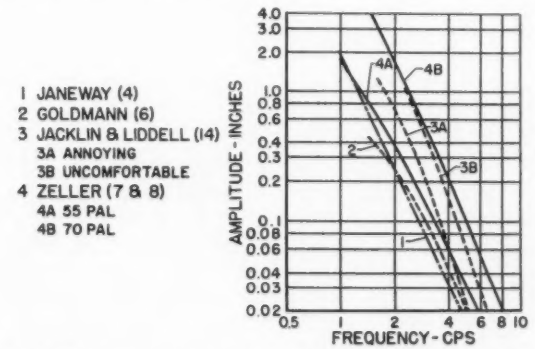


Fig. 6 Maximum tolerable amplitudes in relation to the frequency

1 and 6 cps, with the frequencies most generally encountered in the order of 4 cps, as these values represent the natural frequency of the principal vibrational system (tires and mass) of the tractor. This natural frequency is excited by each jump of the tires.

Jumping of tires occurs frequently, since all obstacles higher than the static tire deflection (1 to 1.38 in)‡ are not absorbed by the tire. The question therefore arises; can these frequencies be attenuated sufficiently by a suitably sprung seat? This may be answered quite clearly by calculations, using the usual assumptions.

For details of the mathematical procedures involved, reference is made to the thorough investigation of motorcycle suspensions by Marquard (15). The author of this paper (Dr. Max Haack) has published a similar technique for analyzing problems arising from consideration of a person on a sprung vehicle axle (16). The principles established by this investigation may be applied to any general case involving agricultural vehicles, provided that the relative values employed are modified properly. Generally, however, the ratio of weights of driver to vehicle lie within the range of 1:10 to 1:20. Therefore, in the above-mentioned paper, the evaluation of the behavior of the seat suspension under resonance conditions furnishes basic knowledge of the reoccurring vibrational conditions of the driver of most contemporary agricultural vehicles.

The ratio between the natural frequency of the seat and that of the vehicle (springing action of tires) can be altered by design only within relatively narrow limits. As the rate of the seat spring is increased from that affording the lowest practical natural frequency to the point where it is equal to the natural frequency of the entire tire-mounted vehicle, the amplitude of the seat displacement increases up to values which are five times as great as the height of the road roughness. This is shown in Fig. 7. Were the hardness of the seat spring increased still further, resonance frequencies increase and maximum amplitudes at resonance decrease. The limit to such a procedure is a rigid connection between seat and rear axle. Under this condition, the vehicle displacement is only 2.5 times the height of the obstacle.

It may therefore be maintained that a sprung seat with a frequency ratio of $\nu > 0.6$ will always have maximum amplitudes greater than a seat without any spring. Increasing the softness of a spring, i.e., decreasing spring rate, is limited to values of $\nu = 0.4$, because of design and operational limitations. It may be concluded therefore that the optimal frequency ratio is in the order of $\nu \approx 0.5$; *i.e.*, a natural frequency of the seat of about 2 cps, when the rear axle has a frequency of about 4 cps. Further consideration of the relationship $\nu = 0.5$ reveals the following:

Were the natural frequency of the rear axle-tire system decreased to 3 cps, as by the use of softer tires, affording an increased static deflection, it then becomes necessary to lower the natural frequency of the seat to 1.5 cps, if optimal

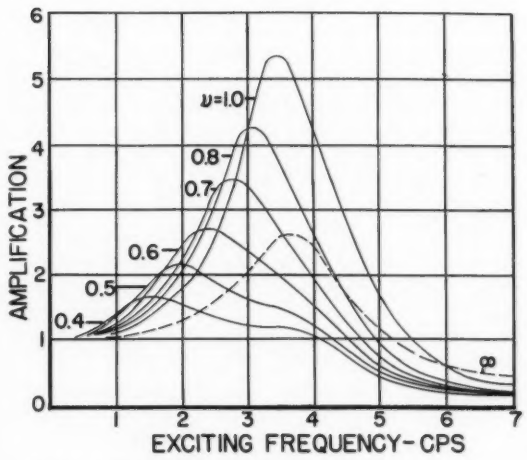


Fig. 7 Resonance curves of the spring-mounted seat as the frequency ratio varies

conditions are to be provided. In such a condition, all sets with a natural frequency higher than $3 \times 0.6 = 1.8$ cps would be more unfavorable than a rigid seat.

More information and data applicable to future designs can be obtained from the above-mentioned paper (16).

Susceptibility to Engine Vibrations

Engine vibrations in a vehicle appear in more than one direction; *i.e.*, an engine with vertical cylinders produces vertical vibrations and horizontal vibrations with almost the same amplitude. Investigations conducted by Bèkèsy (10) show that the human body has the same susceptibility to horizontal as to vertical vibrations. It does not matter if a vertical or horizontal engine ɔe used. Only the exciting frequencies are important, a factor which can be derived from consideration of engine speed and the unbalanced crank and reciprocating forces.

Build-up of tire vibrations can occur only if the frequency of engine vibrations is in the order of 4 or 5 cps (15), such as would be the case at an engine speed below 350 rpm. Today there are no such low-speed engines on the market. Only low-speed idling of the engine can cause resonance vibration of the tractor and tire system—a condition which may be observed frequently in today's tractors. This is of no significance under field operating conditions, since at full engine speed the exciting frequencies of the engine are too high to cause vertical vibrations of the vehicle.

In the first section of this paper, it has been shown that at values above 6 cps, human tolerance to acceleration decreases rapidly. For instance, in considering two tractors, one with a slow-speed engine having an exciting frequency of 10 cps, and the other with a higher speed engine having an exciting frequency of 25 cps, the values of vibrational acceleration of the former may be four times that of the latter, while affording the same measure of sensation to the operator.

Certain danger is involved when only average or mean variations of human susceptibility to vibration are considered. It must never be overlooked that about one-fourth of all human beings are more susceptible to vibration than the

‡Translator's note: American tractors, which are heavier and have larger tires than their European counterparts, have tires which show greater deflection under load and have lower natural frequencies than those given. Representative values of current American practice are as follows:

Nominal tire size	Deflection under load at 12 psi inflation (Goodyear T. & R. Co., catalog data)
10-28	1.8 in
12-38	2.3 in
13-38	2.75 in
18-26 (20-in rim)	3.9 in

"normal" human being (Fig. 2). The decrease of the values of acceleration tolerable to these individuals will start at much lower frequencies. If such persons are driving tractors, which due to a combination of slow speed and inadequate seat suspensions originate severe exciting forces, they may be subject to physical impairment, whereas the average person will not feel any distress.

Conclusion

Present knowledge regarding limiting values of human tolerance to vibrations makes possible the critical investigation of vibration phenomena. It has been shown that the strains resulting from the vibration of agricultural machines driven over rough ground are close to the limit of human tolerance, and frequently even exceed this limit. Adequate attenuation of vibrations having frequencies below 5 cps cannot be achieved by seat suspensions alone. It has to be taken into account that there are persons who are extremely susceptible to vibrations and who may more readily be subject to occupational injuries. A satisfying solution can be expected only by spring mounting all masses in such a manner that the natural frequency of the vehicle is from 1 cps to a maximum of 2 cps. When this is accomplished, the necessarily large deflection of the vehicle suspension system largely eliminates jumping of the vehicle, even when driving over extremely rough farm roads and fields. The strains caused by engine vibrations are considerably smaller than those arising from road roughness, but are still of such a magnitude that great importance attaches to a smooth-running engine.

References

1 Den Hartog, J. P. Mechanische Schwingungen. Berlin (1936).

2 Reiher, H. u., Meister, F. J. Die Empfindlichkeit des Menschen gegen Stösse. Forsch. 3 (1932) p. 177.

3 Meister, F. J. Die physiologische Wertung von Erschütterungs-messungen. Akust. Z. 2 (1937) p. 4.

4 Janeway, R. N. Passenger vibration limits, *SAE Journal* (1948), vol. 56, p. 48.

5 SAE Riding Comfort Research Committee. Ride and vibration data. Special Publication (SP-6), New York (1950).

6 Goldmann, D. E. A review of subjective responses to vibratory motion of human body. Report No. 1. Naval Medical Research Institute. (March, 1948).

7 Zeller, W. Masseinheiten für Schwingungsstärke und Schwingungs-empfindungsstärke. ATZ 51 (1949) p. 95.

8 Zeller, W. Vorschlag für ein Mass der Schwingungsstärke. Z. VDI 77 (1933) p. 323.

9 Postlethwaite, F. Human susceptibility to vibration. *Engg.* 157 (1949) p. 61.

10 Bèkèsy, G .V. Uber die Empfindlichkeit des stehenden und sitzenden Menschen gegen sinusförmige Erschütterungen. Akust. Z. 4 (1939) p. 360.

11 Bèkèsy, G. V. Uber die Vibrationsempfindung. Akust. Z. 4 (1939) p. 316.

12 Wass, H. Messung von Kraftfahrzeugschwingungen. Z. VDI 79 (1935) p. 199.

13 Müller, E. A. Die Wirkung sinusförmiger Vertikalschwingungen auf den sitzenden und stehenden Menschen. Arb. Physiologie 10 (1939) p. 459.

14 Jacklin, H. M. u., Liddell, G. J. Riding comfort analysis. Engineering Bulletin No. 44, Purdue University U. S. (May, 1933).

15 Marquard, E.: Uber das Schwingungsverhalten des Kraft-Rades. ATZ 54 (1952) p. 269.

16 Haack, M. Uber die günstigste Gestaltung der Schleppersitzfederung bei luftbereiften Ackerschleppern mit starrer Hinterachse. Landtechn. Forsch. 3 (1953) p. 1/13.. SAE Transactions, vol. 63 (1955) p. 452-469.

Energy Losses at Draintile Junctions

(Continued from page 252)

grade line has been plotted on the elevation of the sketch (Fig. 6). It will be noted that the pipe is under slight pressure (maximum of ⅜ in on the crown) for much of its length. This pressure will reduce the rate of drainage of the soil slightly, but only slightly. All pressure in the main could have been eliminated if the last 100 ft of main had been increased in size.

Summary

The results of the tests to determine the junction energy loss coefficients for joining pipes are given in Fig. 4 where the lateral is the same size as the main, the junction is sharp-edged, and both the lateral and the main are flowing completely full.

A typical example is worked out to show that *(a)* the junction-energy loss for a 90-deg junction angle is insignificant from a practical standpoint and *(b)* the 90-deg junction will give as satisfactory results for agricultural drainage systems as the more commonly recommended 45-deg junction.

References

1 Naramoto, Itaru and Kasai, Taijiro. On the loss of energy at impact of two confined streams of water. Memoirs of the College of Engineering, Kyushu Imperial University, Fukuoka, Japan, vol. VI, no. III, pp. 189-261, (1931).

2 Vogel, Gustav. Experiments to determine the loss in right angle pipe tees. Translated in U.S. Department of Interior, Bureau of Reclamation Technical Memorandum No. 299, Denver, Colo. (August 3, 1932).

3 Petermann, Franz. Loss in oblique-angled pipe branches. Translated by Herbert N. Eaton and K. Hilding Beij, Authorized translation of Mitteilungen des Hydraulischen Instituts der Technishen Hochschule München, bul. 3, (1929), published by American Society of Mechanical Engineers, pp. 65-77, (1935).

4 Kinne, Emil. Contribution to the knowledge of hydraulic losses in branches. Mitteilungen des Hydraulischen Instituts der Technishen Hochschule München, bul. 4, pp. 70-93, (1931).

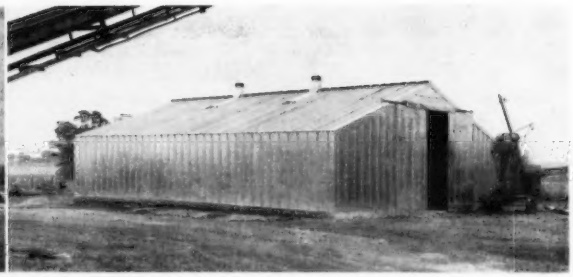
5 McNown, John S. Mechanics of manifold flow. American Society of Civil Engineers, Transactions, vol. 119, pp. 1103-1142. (1954).

Cropland Going Urban

A MILLION acres of rural land are being lost each year to urban development, according to Walter B. Garver, manager, agriculture department, U.S. Chamber of Commerce, writing in *Chemurgic Digest*.

Mr. Garver suggests that the cropland estimate might be high because not all the land taken is cropland. About one-third of it is taken from uses other than agricultural cropping. The remaining ⅔ million acres represents about 0.16 percent of the 408 million acres of cropland reported in the 1950 Census of Agriculture.

Whether regulation or regimentation should be undertaken to protect cropland from "natural and inevitable" forces is questioned by Mr. Garver. He points out that increased use of fertilizers and lime, better control of plant and animal diseases and pests, better seed varieties and more mechanization have added and probably will continue to add to production. It would take a combination of increases in these factors equal to only about one percent per year in yields per acre to supply the 1975 needs of an expanded population at current rates of consumption from the cropland available now.



Two Armco factory-built steel farm buildings • *(Left)* General-purpose, frameless barn, 28 x 96 ft • *(Right)* A 36 x 48-ft grain-storage building of column and purlin construction

Factory-Built Farm Buildings

Deane G. Carter
Life Fellow ASAE

FACTORY-BUILT farm buildings solve some of the most difficult problems of farmstead improvement. For this reason, these buildings are likely to be used increasingly to meet a wide variety of housing and storage requirements on the farm.

The varied nature of farm buildings suggests that "factory-built" be defined in terms broad enough to include licensed pole frames, assemblies of laminated arches and roof trusses, and contractual construction of standard or proprietary types, in addition to structures commonly designated as shop-built, prefabricated, or ready-made.

Factory-built buildings may be classified according to three principal groups as follows:

- *Ready-made structures.* Sold as complete units, usually small hog houses, brooders, self-feeders, holding bins and similar types, but may include more elaborate buildings such as milking rooms and grain storages.
- *Contractual standard structures.* Not prefabricated but sufficiently standardized so that experienced agents can quote prices, sell the buildings, assemble materials, follow established construction practices, and supply service over a considerable area. Included are masonry silos, pole-frame barns, and a number of buildings for specific purposes.
- *The building package.* The newest and most versatile factory-built building, assembled from an array of trusses, frames, sheets, panels, sections, or other parts and pieces, and designed for fast erection on the site by craftsmen having the common skills and using readily available tools. These structures are often made of metal, but not necessarily so. Some are built with laminated arches or wood trusses, plywood, composition materials, and various panel assemblies. Examples include utility buildings, storage sheds, and cylindrical storage bins and cribs.

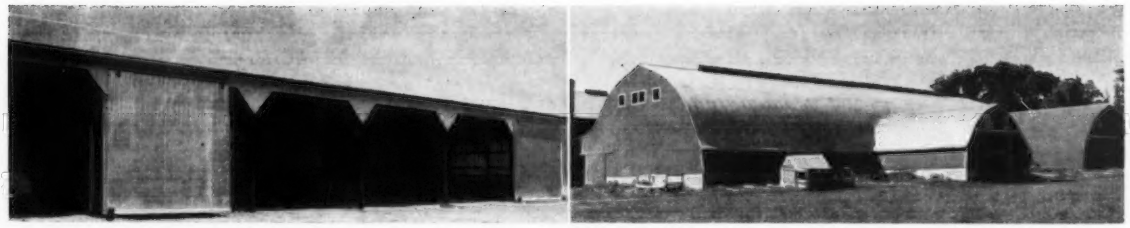
Possibilities for the solution of many difficult problems of farmstead improvement and management have been greatly multiplied by the rapid progress in the past decade in developing factory-built structures to meet the growing and changing requirements on farms

Factory-built buildings may also be classified as to func-

Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1955, on a program arranged by the Farm Structures Division.

The author — DEANE G. CARTER — is professor of farm structures, University of Illinois.

Two types of Stran-Steel factory-built steel farm buildings • *(Left)* A 32 x 72-ft quonset-type, all-purpose building • *(Right)* A rigid-frame-type building specially adapted for housing large farm-operating equipment



Two factory-built farm buildings of aluminum and wood construction • *(Left)* An equipment-storage building combining pole-type construction and Alcoa aluminum roofing and siding sheets • *(Right)* A 50 x 132-ft Rilco-type feeder barn

tion or purpose. In general, the categories in this grouping are:

- *Movable-type animal shelters or equipment.* The familiar feeders, chutes, brooders, holding bins, sun shades, and others, often built in small local shops or by specialty manufacturers.
- *Specialty buildings for crops or animals.* Examples of the special-purpose type structures are laying houses, chopped-hay storages, cylindrical grain bins, bulk-feed holding bins, corn cribs, milkhouses, and hay drier-feeder combinations.
- *Multipurpose utility buildings.* Warehouse-type structures usually characterized by post-free interiors, clear-span roof frames, standard modular heights and widths, and lengths variable by definite segments of distance, sometimes of panel construction and with supplementary or alternate features for high versatility.

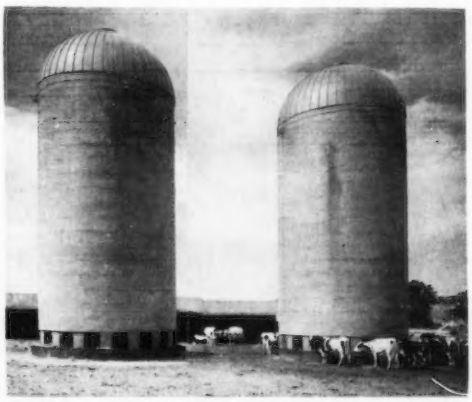
Development

Farmers have long realized that *(a)* buildings go out of date as they become older, more because of changes in the demands on them than because of deterioration, and *(b)* a building specifically designed for a single use is not readily convertible to other functional purposes. These two facts indicate the basic requirements of manufactured buildings: (1) They must either be so well suited to a highly specialized job that they will be chosen for the single purpose, or (2) they must be so adaptable in nature as to fulfill the multipurpose objectives characteristic of today's farming needs.

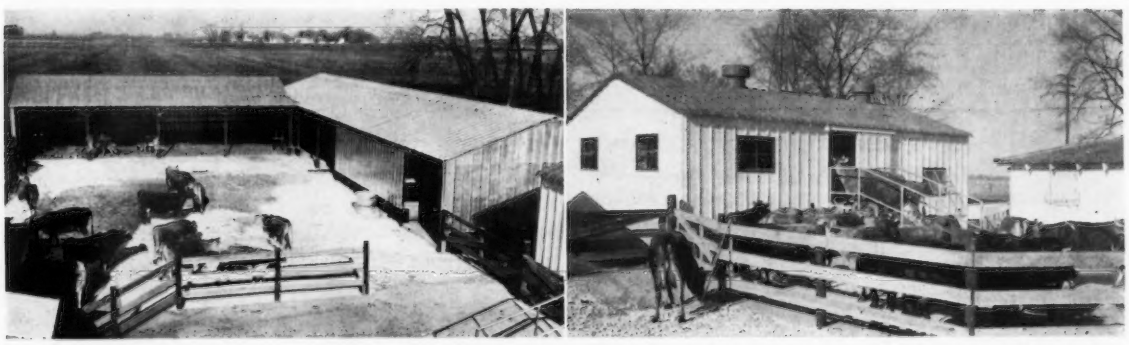
Profound changes in agriculture have forced a departure from conventional practices in virtually every phase of agriculture, so that now a distinctly different type of building need coincides with the time when a great deal of the farm plant must be rebuilt.

The principal influences for change are so well known that only brief mention is needed here to recall them. They include mechanization, the high value placed on labor efficiency, the shift from general-purpose farming to specialization, the consumer demand for clean, high-quality products, the need to prevent loss, and provision for a versatile farm establishment that can change with the times.

Parallel with the development of the modern demand for new farm buildings, industrial developments have occurred in the last 10 years that are particularly favorable to factory-built buildings. These influences include such things as higher construction wages; fewer rural builders; the complexities of small contracting businesses; the economies of mass production; the advancement in supply, manufacture and distribution of treated wood, structural steel, galvanized and aluminum sheets, plywood, laminated framing, timber connectors and millwork, and the modification of industrial structures to farm uses.



Two units of a Martin combined chopped-forage storage and self-feeder



Two views of dairy cattle loafing sheds *(left)* and milking "parlor" *(right)* on a Midwest farm, constructed of U.S. Steel galvanized sheets and structural steel members and fabricated by Butler

Although interest in factory-built buildings is at an all-time high, the industry itself is still very young. Most farm buildings are still made by conventional, on-site procedures, and largely with home or local labor. The farmer is often compelled to alter, repair, or rehabilitate the structures he has, rather than to erect a new building.

Competition will determine which of the manufacturers will drop their farm business — some already have — and which will find a permanent place for themselves. Too much emphasis is sometimes given to particular shapes of roof, modes of construction, kinds of framing or covering material, speed of erection, or cheapness in first cost. Some structures have been overemphasized as ideal solutions to the farmer's problem. Much remains to be done to improve the appearance of factory-built buildings.

In the long run, the farmer's needs, his preference, and his pocketbook will settle the question of which factory-built buildings will survive. They are most likely to be successful if they follow current trends. In the following paragraphs are briefed findings derived from 1955 studies.

Conditions and Trends

A 10-year investigation* of what has been done about buildings on 317 Illinois farms provides the following information:

- *No change* in the number of buildings per farm.
- *New construction* was at the rate of one new building per farm in 10 years; remodeling or additions were made at the rate of one improvement for each two farms in 10 years.
- *Demolition or destruction* accounted for the disappearance of one building per farm in 10 years.
- *Repairs,* mainly painting and reroofing, were made on about one-half the buildings in 10 years, or at a rate of one such improvement per farm every 2½ years.
- *Nothing was done* to about one-half the buildings on these farms.
- *Buildings are getting larger,* because the new structures are somewhat larger than the ones that were demolished.
- *Buildings are getting older,* mainly because of the slow replacement rate. The average age of farm buildings increased by 8 years in the 10-year period.
- *There are fewer* general-purpose barns, poultry houses, and "miscellaneous" buildings now than there were in 1945.
- *There are more* silos, dairy buildings, factory-built cribs and bins, and machinery storages than there were in 1945.
- *The most common structural features* on the new buildings are gable-roof shape, metal-roof covering, wood framing and siding, and concrete foundation.
- *Gains were made* in the proportion of buildings with masonry walls, pole frames, and galvanized steel and aluminum coverings.

*From field studies by Carter, Clayton, Kay, Irish and Matthews, made at the Illinois Agricultural Experiment Station.

An up-to-the-minute glimpse of farm building trends is afforded by the following summation from entries in a 1955 nation-wide building improvement contest conducted by *Farm Journal* in cooperation with the National Lumber Manufacturers Association:

- *Nine out of ten* improvements involved permanent or fixed-in-place structures, rather than small, movable buildings and devices.
- *Remodeling of existing buildings* accounted for about one-third of the improvements.
- *Construction or alteration of dairy structures* was the most common building activity, although dairy farms are in the minority.
- *Loose-housing dairy structures* were far ahead of other dairy buildings in number of contest entries.
- *Utility-type buildings*—machinery storages, shops, garages, and multipurpose buildings — were second high following dairy structures.
- *The cost per improvement* was $1,000; this was the medium cash outlay, not counting salvage, farm-produced materials, or the farmer's own labor.
- *Trends in 1955,* on the basis of contest entries, were toward greater emphasis on the following phases:

Central farrowing	Remodeling of old buildings
Loose-housing dairy	Grade A milk production
Larger poultry flocks	Better quality products
Mechanized feeding	Bulk feed handling
Loss prevention	Effective utilization of labor

Strength-Toughness Balance in Fasteners

EVEN though it is important that a fastener have strength, it must also have suitable ductibility or toughness, point out Russell, Burdsall & Ward, fastener specialists. They report that as a general rule, the greater the tensile strength, the less the ductility. Therefore, the correct proportion of tensile strength and ductility must be obtained for each specified set of conditions.

The proper balance between tensile strength and ductility, is provided by heat-treatment. Cold-working increases tensile strength, but it does so at the expense of ductility. Further, it is more difficult to control the amount of tensile strength.

Thus, when toughness is required to withstand heavy load conditions, it is necessary to select the suitable steel and heat-treatment to obtain the optimum combination of tensile strength and ductility. For example:

High-carbon capscrews, which can be identified by their black finish and three radial lines on the head are designed for heavy load conditions and are quenched and tempered, to obtain the best combination of physical properties.

Cold-headed machine bolts are stress-relief annealed after cold-working to increase ductility.

Low-carbon cap screws, which have a bright finish and are intended for applications where appearance is paramount, are not heat-treated after cold-working.

Improved Soil Moisture Meter

George J. Bouyoucos

When, how much, and how deep to irrigate are basic questions to which the irrigator requires reliable answers each time he applies irrigation water to cropland. The author in this article reviews latest improvements in a soil moisture meter and related equipment widely used in recent years as a scientific guide to irrigation

CHANGE can be a basis for progress. This paper presents the latest changes and improvements that have been made in the moisture meter used in connection with plaster-of-paris blocks as a scientific guide to irrigation. This meter was first introduced in 1950 as a simple, quick and practical method for telling the farmer when it is necessary to irrigate, how much to irrigate, and how deep the applied water has penetrated the soil(1)*.

The meter in its original form was an alternating-current impedence meter based on the circuit of a special soil moisture Wheatstone bridge(2). It was powered by dry batteries and employed vacuum tubes and a rectifier. It was calibrated to read directly from 0 to 100 percent of available soil moisture.

The moisture meter in its latest form, as shown in Fig. 1, has undergone considerable change and improvement and varies the original meter in the following respects:

1 It has a transistor instead of vacuum tubes. The transistor not only has a longer life than the vacuum tubes; it also prolongs the life of the batteries and imparts greater stability to the performance of the meter.

2 The new meter contains an improved circuit which minimizes or eliminates capacitance effects and makes it possible to employ leads up to 250 ft in length, without appreciable error in the meter readings. This is especially true at the higher levels of water content. The following experimental data illustrate this point:

Resistance by bridge, ohms	Available soil moisture, per cent 5-ft leads	250-ft leads
500	98.0	98.0
1,850	53.0	53.5
3,750	41.0	42.0
12,000	19.0	20.5
29,000	9.0	13.0

In contrast to the above results with the new meter, the original meter could not be used with leads longer than 12 ft even at the higher moisture contents. It is probable that it will seldom be found necessary to use leads of 250-ft lengths. Therefore, the new meter readings can be said to be unaffected by reasonable lengths of leads for the entire range of the available water content.

3 The scale of the new meter is calibrated to give not only percentage of available water, but also the corresponding resistance in ohms. This resistance scale makes the new meter a more versatile instrument. For example, it enables the operator to prepare a separate moisture curve for any unusual soil which does not closely follow the generalized soil moisture curve. Such a generalized curve (Fig. 2) showing available soil moisture plotted against resistance, is a part of the instrument scale. In addition, the resistance scale enables the operator to obtain a general idea of the comparative salt content of the various soils at the highest water content.

4 The new meter is more sensitive through the entire range of the scale, but especially so at the higher level of

Paper prepared expressly for AGRICULTURAL ENGINEERING. Contribution from the soil science department of the Michigan Agricultural Experiment Station, East Lansing; authorized for publication by the Director as Journal Article No. 1868.

The author — GEORGE J. BOUYOUCOS — is research professor of soil science, Michigan Agricultural Experiment Station.

Author's Note: The improved soil moisture meter described in this article, as well as the new plaster-of-paris blocks and other related equipment, is now being manufactured and distributed by Industrial Instruments, Inc., Cedar Grove, N. J., which has acquired the business from Wood and Metal Products.

*Numbers in parentheses refer to the appended references.

Fig. 1 Soil moisture meter and plaster-of-paris block in which have been incorporated the latest changes and improvements

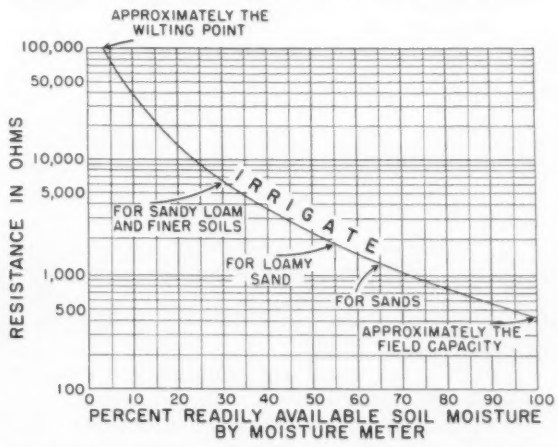


Fig. 2 The curve shows the percentage of readily available water in soils as measured by the soil moisture meter and recommendations for irrigating

water content. In the old meter the scale was congested in the range of 80 to 100 per cent of available water, which is an important range. In the new meter the scale is wider in this range thus making it more sensitive. However, the less used range of 0-10 per cent is compressed and made less sensitive.

5 The new meter has a strap attached which makes it more convenient to hold and carry.

6 By fortunate coincidence, the improved features of the meter, as described above, are reinforced and enhanced by improved features of the recently introduced improved plaster-of-paris blocks. The original blocks were made with single-wire electrodes having high capacitance, which naturally affected the accuracy of the meter. The new blocks are constructed with 20-mesh screen, stainless-steel electrodes which are platinized. These platinized-screen electrodes greatly improve the electrical performance of the blocks. First, they eliminate or greatly minimize "stray currents" or electrical lines of force. Second, they eliminate or minimize the capacitance of the blocks themselves, and thus increase the accuracy of the meter, since this capacitance cannot be neutralized in the meter. Due to the increased effective surface area of the screen electrodes, the new blocks have practically no polarization. Third, they add greatly to the stability and uniformity of the performance of the new blocks. Fourth, they increase appreciably the sensitivity of the blocks. The new blocks which incorporate these improvements have been still further improved by impregnating them with nylon resin for longer life in the soils (4).

Referring to Fig. 2, generalizations are often hazardous and inadequate. However, due to differences in water release and in reserve available water in the different textured soils, irrigation water should be applied to soils according to the moisture meter at approximately the following levels:

Sand	60 - 70 percent available water
Loamy sand	50 - 60 " " "
Sandy loam and finer soils	30 - 40 " " "

The amount of irrigation water that is added depends upon the degree of wetness of the different depths of the soil. For example, if the 6-in depth calls for water but the depths below 6-in are wet, then enough water is added to wet only the upper 6 in. If, on the other hand, the 24-in depth calls for water, then enough water is added until the 24-in depth becomes wet.

As stated before, the improved moisture meter is of the alternating-current type. At this point, however, some pertinent facts should be presented in regards to the direct-current type of meter. Because the d-c meter can be manufactured more inexpensively than the a-c meter, a very intensive and extensive study has been made on it. This study on the d-c meter has revealed the following facts and conclusions:

(a) The d-c meter is not sensitive and reliable in measuring soil moisture at the higher levels of water content.

(b) The d-c meter readings tend to give very rapid and pronounced drifting and erratic performance, especially at the higher moisture levels.

(c) The d-c meter readings are markedly influenced by polarization and hydrolysis.

(d) The relatively expensive batteries in the d-c meter are very short-lived, and in large-scale irrigation operations they have to be frequently replaced offsetting the initial low cost of the instrument.

In other words, the fundamental principle of the d-c meter is not suited for soil moisture measurements. It is as unsound as is the fundamental principle of the bare soil moisture electrodes which were used before the advent of the plaster-of-paris blocks(7). The current introduction of a soil probe utilizing a d-c meter and bare electrodes was found to give misleading results. If the probe was inserted in a compact soil, it indicated wet conditions even though the soil was near the wilting point. If the soil was loose, entirely different readings were obtained.

The alternating-current type of moisture meter and the plaster-of-paris type of moisture block have a sound fundamental principle and consequently lend themselves to a satisfactory and dependable method for measuring soil moisture, especially for irrigation purposes.

References

1 Bouyoucos, G. J. A practical soil moisture meter as a scientific guide to irrigation practices. *Agr. Journ.* 42: 104-107 (1950).

2 Bouyoucos, G. J., and Mick, A. H. An electrical resistance method for the continuous measurement of soil moisture under field conditions. Mich. Agr. Exp. Sta. Tech. Bul. 172. (1940).

3 ..... Improvements in the plaster-of-paris absorption block electrical resistance method for measuring soil moisture under field conditions. *Soil Sci.* 63: 455-465 (1946).

4 Bouyoucos, G. J. More durable plaster-of-paris moisture blocks. *Soil Sci.* 76: 447-451 (1953).

5 ..... New type of electrode for plaster-of-paris moisture blocks. *Soil Sci.* 78: 339-342 (1954).

6 ..... Electrical resistance methods as finally perfected for making continuous measurement of soil moisture content under field conditions. Quarterly Bul. Mich. Agr. Expt. Sta. 37: 132-149 (1953).

7 ..... Capillary rise of water in soils under field conditions. *Jour. Phys. Chem.* 57: 45-49 (1953).

U.S. Zinc Consumption Up

THE American Zinc Institute reports that the United States is the largest consumer of zinc in the world. Though the United States has only 7 percent of the world's population, it consumes 40 percent of the world's primary zinc — at a rate of 11.4 lb per capita. This compares favorably with the United Kingdom's 7.6 lb per capita and France's 6.2 lb per capita.

The largest use for zinc is in galvanizing. In 1954, 45 percent of the zinc consumed went into galvanized steel, or 398,599 tons. Of this 181,165 tons were consumed in galvanized sheet and strip. The 1955 zinc consumption for galvanizing is expected to have exceeded 410,000 tons.

The production of slab zinc at United States smelters ran 15 percent ahead of 1954 levels. The overall supply has been more than sufficient to take care of domestic consumption in spite of increased demand. Domestic mine production was higher in 1955 and was supplemented by substantial imports of foreign concentrates.

Current production capacity of galvanized sheet and strip is in excess of 3,300,000 net tons. More than 1,716,000 tons of this are in modern continuous hot dipped galvanizing lines. These new lines are rapidly replacing conventional batch methods for galvanizing steel. The lines now under construction represent a capacity of some 823,000 tons of sheet and strip with additional lines representing another 200,000 tons on the drawing boards or under consideration. It is estimated that by the end of 1956, continuous hot-dip lines will account for more than three-fourths of capacity.

Estimating Irrigation Border Flow

Warren A. Hall
Member ASAE

A practical method for predicting the rate of water advance down an irrigation border simplifies design of border-strip checks

IN THE design of border-strip checks an attempt is made to determine the best slope, quantity of flow, width of border, and precision of the grading operation compatible with the roughness of the bottom of the check, the infiltration characteristics of the soil and the depth of rooting zone to be replenished, i.e., the total quantity of water to be applied. Criddle and Davis (1)* reveal that the design problem can be simplified somewhat if data can be obtained as functions of time for the advance of the water front down the border and for the recession of water in the border after inflow ceases. Some attempts have been made by Lewis and Milne in 1938 (2) to derive an expression for the advance of the water front as a function of time, rate of flow, depth of water in the check and the infiltration characteristics of the soil. The equation given by Lewis and Milne presumes that the effect of slope and surface roughness on the rate of advance is reflected in the depth (which is estimated beforehand). The equation does not appear to have a wide acceptance by system designers, possibly because of the mathematical complexity and possibly because it does not give directly, information concerning the effects of slope (one of the few variables at the designer's disposal), nor concerning the surface roughness of one of the variables of the actual system.

On the other hand, the usual experimental approach to the design problem also leaves much to be desired since the system must be constructed in most instances before the design data can be obtained. Thus the data become simply operational criteria for the farmer and do not provide the system designer or the project planner needed preconstruction design factors.

Most border irrigation systems are operated on the basis of water being turned into a check until the front reaches the far end, at which time it is turned out. The advance of the water front as a function of time, roughness, slope, flow rate, depth of water in the check and infiltration characteristics of the soil is therefore the most important factor in system design. The second most important factor is whether the aboveground storage of water at the time water is turned out of the check is ample to complete the irrigation adequately, allowing for tail water losses, if any. The third important factor concerns the recession of the water in the check as a function of time. This factor determines to a large extent the uniformity of the irrigation. In the following discussion a method of obtaining the first factor will be outlined.

Derivation of Equations

The method to be used to obtain the advance of the water front will be essentially a numerical integration. When water is let into a check b feet wide at a discharge rate of Q_o cubic feet per second, a part of the water enters the soil at an infiltration rate $r=r(t)$, a function of time after initial wetting. The rest of the water fills a volume V (hereafter referred to as storage) above the surface of the ground. For a given roughness as expressed by Kutter's n and a water surface slope S_o at the head of the check, a depth d_o will be reached such that the flow rate down the check is equal to the inflow rate of Q_o.

$$Q_o=(1.49/n_o)d_o^{5/3}\ S_o^{1/2}b \quad . \quad . \quad . \quad . \quad [1]$$

Define an infiltration function $y\ (t)$ as the total quantity of water per unit area which has entered the soil t units of time after water is applied initially (and continuously).

Stated mathematically

$$y(t)=\int_o^t r(t)dt \, . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [2]$$

The infiltration function must be measured experimentally and considerable care must be taken to insure reasonable results. In addition to problems posed by actual variability over the field, it is rather difficult to obtain the desired one-dimensional infiltration rate at a point since the latter is essentially three dimensional. When making determinations with buffered-ring infiltrometers, care should be taken that the water level in the buffer is the same as that in the measuring ring (3). Also, the depth of water in the infiltrometer should be as nearly equal as possible to the expected depth of water in the check. Since the accumulated infiltration rather than the rate is to be obtained, the technique is simplified since the water level need only be brought back to a mark at the time of an observation. The total water added since the beginning can be noted. The experimentally determined function can be expected to show a higher infiltration rate than the actual one-dimensional rate.

The relationship between the total infiltration and distance down the check is given by the curves in Fig. 1 with time as parameter. On an axis vertically downward from a horizontal line representing the soil surface, there is plotted a series of points representing to scale the total infiltration at the end of successive equal-time increments. Through each of these points, a horizontal line is drawn. At any dis-

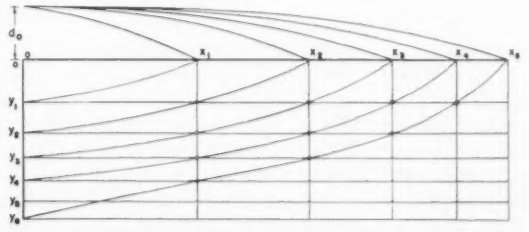


Fig. 1 Accumulative infiltration as a function position of the wetting front with time as a parameter

Paper prepared expressly for AGRICULTURAL ENGINEERING.

The author—WARREN A. HALL—is assistant professor of irrigation, University of California, Davis.

*Numbers in parentheses refer to the appended references.

tance x down the check the depth of water applied to the soil is determined only by the time elapsed since water first reached that point. If it is presumed that on the average the infiltration characteristics are uniform at all points of the check, the horizontal lines so drawn represent the total depth of application at the corresponding instants in time after water reaches the point considered. By the end of the first time increment, the water will have reached x_1. By the end of the second time increment, the depth of application at $x=0$ will be y_2, the depth of application at x_1 will be y_1 and the water will have just reached x_2. A curve passing through the points $(0,y_2)$, (x_1, y_1) and $(x_2, 0)$ represents the accumulated depth of application as a function of distance down the check at time $t=2\Delta t$. Similarly a curve through the points $(0, y_3)$, $(x_1 y_1)$ and $(x_3, 0)$ is the accumulated application curve for time $t=3\Delta t$. Other such curves for $t=\Delta t$, $t=4\Delta t$ and $t=5\Delta t$ are also shown illustrating the method of constructing these curves. The area between any two successive curves is equal to the total volume of water applied to the soil per foot of check width during the corresponding time interval Δt.

In addition to the storage which occurs in the soil as described above, there is a storage of water represented by the depth of water in the check. Depending upon the slope and roughness, there is a minimum depth d_o necessary at the head of the check to pass the discharge per foot of width turned into the check. This depth is obtained directly from equation [1] and represents the minimum steady flow depth. Since the depth will be small compared with the distance water will move in the first time increment, at normal calculation the value obtained using the true water surface slope will be nearly that obtained using the ground slope.

The depth of water calculated in this manner is that minimum depth necessary for the required flow to occur at the nominal roughness and slope of the channel. However, it does not include the average depth of water which must be applied to the check, to fill the pockets, etc., caused by the unevenness of the surface of the check, before flow can occur. Thus for purposes of surface storage, a correction must be applied representing the average depth of water which would remain on the surface of the check after the water was turned off, presuming the soil had zero permeability. This average depth correction will be termed the puddle factor, denoted by e. It is a measure of the average unevenness of the check.

The depth of water necessary for flow past successive points down the check will decrease since the total flow past these points decreases. The water depth thus becomes a function of the distance down the check. While the depth of water at each station can be computed as the analysis by this method proceeds, the amount of calculation is greatly increased. A simpler approach is to presume that the type of function represented by the water surface is the same for all instants of time. With this postulation, the ratio of the actual volume of surface storage to the volume of the circumscribing parallelopiped is a constant c, which from *a priori* reasoning must be greater than one-half but less than one. For example, if the equation of the water surface happened to be a cubical parabola with vertex on the x axis at the point in question, the value of the constant ratio is 0.75. If a normal parabola, it is 0.667, etc. Therefore, the storage volume V_s above the soil surface at any instant of time t_i is equal to

$$V_{si}=b(d_o c+e)\ x_i \qquad [3]$$

The increment of surface-storage volume which occurs during any time interval is equal to the difference between the surface-storage volumes at the beginning and end of the time interval.

$$\text{Thus } \Delta V_{si}=b(cd_o+e)\Delta x_i \qquad [4]$$

The increment of the volume of water stored in the soil is equal to the area between two successive total-application curves multiplied by the width of the check. In Fig. 1, for the fifth time increment, this is the area whose corners are y_4, x_4, x_5, y_5. The trapezoidal rule will be used to determine the area all except the last three cornered elements below Δx_5. This last element can be estimated in the same manner as the surface volume by presuming that the shape of the curve in this last element is a constant. The ratio of the actual cross sectional area to the area of the rectangle circumscribing it will be a constant k whose value from *a priori* reasoning again lies between one-half and one. The increment of volume applied to the soil ΔV_{ai} is therefore given by

$$\begin{aligned}\Delta V_{ai}/b=&\tfrac{1}{2}[(y_i-y_{i-1})+(y_{i-1}-y_{i-2})]\Delta x_1+\\&\tfrac{1}{2}[(y_{i-1}-y_{i-2})+(y_{i-2}-y_{i-3})]\Delta x_2+\ldots+\\&\tfrac{1}{2}[(y_2-y_1)+(y_1-0)]\Delta x_{i-1}+ky_1\Delta x_i \qquad [5]\end{aligned}$$

Equation [5] can be simplified by performing the operations indicated within the brackets and substituting a factor defined by

$$a_i=(y_i-Y_{i-2})/2 \qquad i\geqq 2 \qquad [6]$$

By the law of conservation of matter the quantity of water flowing into the check during any time increment must be equal to the sum of the increments of storage produced. Using equations [5] and [6] the mass balance for the check during any time increment is for $i\geqq 2$

$$\begin{aligned}Q_o\Delta t/b=&a_i\Delta x_1+a_{i-1}\Delta x_2+\ldots+a_2\Delta x_{i-2}+\\&(ky_1+\text{colo}+e)\Delta x_i \qquad [7]\end{aligned}$$

SAMPLE CALCULATION

DATA

$Q = 0.75$ ft³/sec-ft
$S = 0.005$
$n = 0.035$
$e = 0.10$ ft
$c = 0.75$

$k = 0.75$
$d_o = 0.110$ ft
$y_1 = 0.076$
$B = ky_1 + cd_o + e = .240$

$x_1 = Q\Delta t/B$
$x_i = Q\Delta t/B - \Sigma a_i \Delta x_j/B$

t		5	10	15	20	25	30
	$\Sigma\Delta x_i$	93.7	160.1	212.2	256.1		
	Δx_i	93.7	66.4	52.1	43.9		
	$\Sigma a_i \Delta x_j$		6.56	9.99	11.93	13.41	
	a_i	$a_i x_1$	$a_i x_2$	$a_i x_3$	$a_i x_4$	$a_i x_5$	$a_i x_6$
10	0.070	6.56	4.65	3.65	3.07		
15	0.0570	5.34	3.78	2.97	2.50		
20	0.0430	4.50	3.19	2.50	2.11		
25	0.0446	4.18	2.96	2.32	1.96		
30	0.0421	3.94	2.80	2.19	1.85		
35	0.0401	3.76	2.66	2.09	1.76		
40	0.0384	3.60	2.55	2.00	1.69		
45	0.0366	3.43	2.43	1.91	1.61		
50	0.0350	3.28	2.32	1.82	1.54		
55	0.0335	3.14	2.22	1.75	1.47		
60	0.0320	3.00	2.12	1.67	1.40		
65	0.0305	2.86	2.03	1.59	1.34		
70	0.0286	2.68	1.90	1.49	1.26		
75	0.0277	2.60	1.84	1.44	1.22		
80	0.0262	2.45	1.74	1.37	1.15		
85	0.0250	2.34	1.66	1.30	1.10		
90	0.0238	2.23	1.58	1.24			
95	0.0226	2.12	1.50				
100	0.0215	2.01					

Fig. 2 Sample calculation showing a form to speed computations

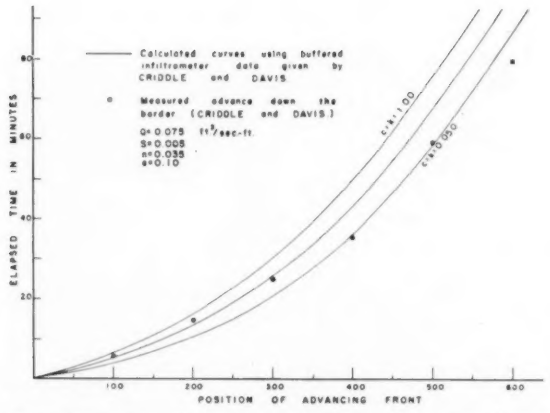


Fig. 3 Comparison of the calculated position of the water front to the observed position under similar circumstances

Solving for Δx_i *for* $i \geqq 2$

$$\Delta x_i = Q_o \Delta t/b - (a_i \Delta x_1 + \ldots + a_2 \Delta x_{i-2})/(k y_1 + c d_o + e) \quad [8]$$

For Δx_1 the solution is simply

$$\Delta x_1 = Q_o \Delta t/b(k y_1 + c d_o + e) \quad [9]$$

The value of Δx_1 is obtained from equation [9] and substituted into equation [8] for $i=2$ to obtain Δx_2. This value is substituted in turn in equation [8] for $i=3$ to obtain Δx_3, etc. A sample calculation showing a form to expedite the calculations is shown in Fig. 2. The a_i are calculated directly from the experimental total infiltration function. While not necessary, the calculations proceed more logically if the a_i are plotted and smoothed values used in the calculations. The sum in the parentheses of equation [8] is simply the sum of all numbers on a diagonal upward and to the right as indicated by the arrow in Fig. 2.

Discussion of Equations

The equations obtained were based in general upon accepted laws and equations of hydraulics. However, certain postulations were made in order to reduce the labor of the computations. These postulates primarily concerned the constants k and c. Additional factors affecting the accuracy of the results are the experimental accuracies with which the infiltration data can be determined (most important) and the accuracy of the estimates of the puddle factor and surface roughness. Indeed none of these values can be expected to remain constant during the season or from year to year except possibly as average values. Some comments are in order as to the effect of these possible errors.

The storage volume represented by total application to the soil will usually be much larger than the surface storage on soils of good permeability. From the appearance of equation [8] it would therefore appear that some error in estimating e, c, k or n will have much less effect on the result than errors in Q_o or $y(t)$. This is borne out by sample calculations on permeable soils. Likewise from equation [8], it may be observed that Q_o will be most important for determining the first increments of distance while $y(t)$ will be more important in determining later increments of distance. For this reason, more tolerance can be allowed in infiltration data for short runs than for longer runs. This is advantageous since the most efficient length of run increases as the infiltration rate decreases and low infiltration rates should be subject to less error in measurement than high rates.

In order to check the shape of the rate of advance curve obtained by this method, there are plotted in Fig. 3 curves calculated for conditions corresponding as nearly as possible to those given by Criddle and Davis (1951) (1) for a border trial with buffered-ring infiltrometer data, slope and discharge specified. The friction factor was estimated to be 0.035 and the puddle factor was taken as 0.1 (border in wheat about 6 in high). The upper curve, $c=k=1$ represents one limit of the range of possible values, while the lower curve, $c=k=0.5$ represents the other limit. Although not shown, a reduction in the given infiltrometer data of less than 10 percent will place the $c=k=0.75$ curve practically on the experimental points. Infiltrometer data is usually somewhat high even when buffered. Further, variations in infiltrometer data of at least this order of magnitude can be expected. It would appear therefore that this method of computing is well within the accuracy of the infiltrometer data.

Summary

There has been presented a simple, numerical method of predicting the rate of advance of water in a border check using data which may be obtained or estimated at any time in the interval from preliminary project planning stages to completed border systems. The time required to make the calculations has proved to be less than the time required to make a border trial in the field, not including preparatory work of staking, installing flow measuring equipment, etc. It would appear to possess an advantage over the equations of Lewis and Milne in that the infiltration data does not have to be forced to fit any predetermined functional relationship (an advantage in soil possessing any degree of stratification). A less important advantage is that no functions unfamiliar to the routine calculator are required. Like any equation, its accuracy in the final analysis is determined largely by the accuracy of the data used in the calculations.

The most important applications would appear to be in the preliminary project planning and distribution system design stages, more so than after the water is delivered to the farm. The rate of discharge needed to irrigate border checks efficiently and economically should be designed into any irrigation project to avoid serious discrepancies between the quantity needed for effective irrigation and the quantity delivered.

References

1 Criddle, W. D. and Davis, S. A method for evaluating border irrigation layouts (Provisional). U.S. Dept. of Agr. Soil Conservation Service, (March 1951).

2 Lewis, M. R. and Milne, W. E. Analysis of border irrigation, AGRICULTURAL ENGINEERING, vol. 19, (June 1938).

3 Schiff, L. The effects of surface head on infiltration rates, Trans. Amer. Geophys. Union, vol. 34, pp. 257-266, (1953).

Guide for Engineers Entering Military Service

A SUMMARY of information helpful in relating agricultural engineering training and experience to military occupational specialties has been prepared by the ASAE Committee on Engineers' Classification in Civilian and Military Service. Mimeographed copies are available on request to ASAE, St. Joseph, Michigan.

NEWS SECTION

ASAE Officers for 1956-57

THE following new officers of the American Society of Agricultural Engineers were elected as a result of the regular election conducted by letter ballot of its corporate members, and will take office at the close of the Society's annual meeting to be held at Roanoke, Va., June 17 to 20:

President — Roy Bainer, chairman of agricultural engineering department (Davis) and assistant dean of engineering (Berkeley and Los Angeles), University of California.

Vice-President (3-year term) — Peter T. Montfort, rural electrification research specialist, A. & M. College of Texas, College Station.

Councilor (3-year term) — David C. Sprague, buyer and director of specifications and quality control, farm supplies division, Cooperative Grange League Federation Exchange, Inc., Ithaca, N. Y.

Nominating Committee — Walter M. Carleton (chairman), agricultural engineering department, Michigan State University, East Lansing; G. Wallace Giles, head, agricultural engineering department, North Carolina State College, Raleigh; J. Roberts, chairman, agricultural engineering department, State College of Washington, Pullman; Charles E. Ball, associate editor of *Farm Journal*, Dallas, Tex.; and Russell R. Raney, chief engineer, New Idea Farm Equipment Co., Coldwater, Ohio.

The members of the Council for the Society year of 1956-57 will include the above newly-elected officers together with the following: Wayne H. Worthington and George B. Nutt, past-presidents; H. H. Beaty and H. J. Barre, vice-presidents; R. K. Frevert and G. M. Eveleth, councilors.

Members of the Society are invited to send any member of the Nominating Committee such suggestions as they may have for nominees for election of officers of the Society in the next annual election of officers which will be held early in 1957. It is desirable that such suggestions reach the Nominating Committee on or before June 1, 1956.

ASAE Meetings Calendar

April 12 and 13—PENNSYLVANIA SECTION, Hetzel Union Bldg., Pennsylvania State University, University Park.

April 20 — QUAD CITY SECTION, International Harvester Farmall Works, Rock Island, Ill.

April 20 — MICHIGAN SECTION, Dearborn Inn, Dearborn

April 20 and 21—ALABAMA SECTION, Dothan

April 20 and 21—FLORIDA SECTION, University of Florida, Gainesville

April 26—MINNESOTA SECTION, AE Building, Farm Campus, University of Minnesota, St. Paul

June 1, 2 and 3 — TENNESSEE SECTION, Watts-Bar Resort Village, Spring City.

June 17-20—49TH ANNUAL MEETING, Hotel Roanoke, Roanoke, Va.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

ASAE Elected to Engineers Joint Council

THE executive committee of Engineers Joint Council and constituent society members have approved the election of the American Society of Agricultural Engineers as an associate member of Engineers Joint Council, effective February 24, 1956.

The Engineers Joint Council is composed of national engineering societies. The objectives of the Council as expressed in the constitution are: (a) to advance the general welfare of mankind through the available resources and creative ability of the engineering profession, (b) to promote cooperation among the various branches of the engineering profession, (c) to advance the science and profession of engineering, and (d) to develop sound public policies respecting national and international affairs wherein the engineering profession can be helpful through the services of the members of the engineering profession.

Privileges of an associate society of EJC include the right *(a)* to nominate representatives to serve as members of committees, *(b)* to receive notices, agenda, and minutes of the meetings of the EJC board of directors and to send to such meetings an observer who is an officer or a member of its governing body *(c)* to designate representatives to take part in the EJC general assembly meetings, and *(d)* to receive periodic information on EJC activities.

When an associate member has a total of over 5,000, it is privileged to apply for election as a consultant society of EJC.

A group of staff members of the agricultural engineering department at Oklahoma A. and M. College inspect a model of a glued laminated arched building used in connection with the sixth annual training course for rural lumber and material dealers sponsored by the agricultural engineering department and the Oklahoma Lumbermen's Association. Inspecting the model *(left to right)* are George W. A. Mahoney and J. I. Fryrear, agricultural engineering; E. W. Schroeder, head, agricultural engineering; Gene Mills, short course instructor; Gordon Nelson, agricultural engineering, and R. A. Parker, short course instructor

Agricultural Engineers Sponsor Builders' Short Course

THE agricultural engineering department of Oklahoma A. and M. College in cooperation with the Oklahoma Lumbermen's Association sponsored the sixth annual short course on farm and light building construction, March 7 to 10. Thirty-one lumber and material dealers, light construction foremen, and representatives of the building trade registered for the three day short course.

The program included talks and discussion on various phases of merchandizing in the farm building construction field, technical aspects of farm and other light building construction and proper application of construction materials, by agricultural engineering department staff members. G. L. Nelson discussed fundamentals of light building construction, and insulation and moisture control in light building construction. George W. A. Mahoney presented some new information on pole-frame construction developed by Oklahoma Agricultural Experiment Station research. J. I. Fryrear presented a demonstration on the use of a new jig for prefabrication of panels for residential construction. Other demonstrations were given at the Agricultural Engineering Laboratories on trussed rafter performance and testing, glued laminated rafter testing, and construction of glued laminated rafters. An intensive series of lessons on material estimating for residences and light buildings was presented by a representative of the Johns-Manville Corp.

Fluid Power Meeting

THE annual spring meeting of the National Fluid Power Association will be held at The Greenbrier, White Sulphur Springs, W. Va., on May 28-30.

The first day will be devoted primarily to marketing subjects, the second day to public, industrial and government relations and to education, and the third day to technical matters of which trends and progress toward standardization of terminology, rating factors and limited dimensions will predominate. Representatives of non-member companies are welcome and may obtain information from the Association's executive secretary, 1618 Orrington Ave., Evanston, Illinois.

VPI Campus Tour to Be Feature of ASAE 49th Annual Meeting, June 17 to 20

A bus tour of the Virginia Polytechnic Institute campus is being planned for members and friends of ASAE during its 1956 Annual Meeting. *(Left)* View of the VPI campus buildings. *(Right)* The new agricultural engineering building to be named Seitz Hall in honor of Professor Charles E. Seitz at a brief ceremony during the tour, June 18

New AE Building Honors C. E. Seitz

THE new agricultural engineering building at the Virginia Polytechnic Institute, Blacksburg, will be officially named Seitz Hall at a brief ceremony during a bus tour of the VPI campus June 18. The bus tour is being planned for members and friends of ASAE attending the 49th Annual Meeting in Roanoke.

The new building will be named in honor of Charles E. Seitz, who organized the department of agricultural engineering at VPI in 1919. He established a four-year curriculum and made VPI the first college east of the Mississippi River to offer a B.S. degree in the subject. He organized the research program in the Virginia Agricultural Experiment Station and has served as head of the agricultural engineering department until his recent retirement.

Mr. Seitz is a past-president and life fellow of ASAE and 1951 recipient of the Cyrus Hall McCormick Medal. In 1955 he was named "Man of the Year in Southern Agriculture" by the publication *Progressive Farmer*. On retiring as head of VPI's agricultural engineering department, he was appointed a member of the newly established VPI-Blacksburg Water Authority, of which he was recently made chairman.

Fire Protection Association Annual Meeting in June

THE 60th annual meeting of the National Fire Protection Association will be held at the Hotel Statler, Boston, Mass., June 4 to 8. On Monday, June 4, simultaneous sessions will be scheduled. An all-day aviation seminar will be held and the Engineering Advisory Council of the National Board of Fire Underwriters will meet. A general session is scheduled for Tuesday morning. James R. Killian, president of MIT, will be guest speaker at the Wednesday evening banquet. Friday afternoon a visit to the Factory Mutual Laboratories in Norwood is planned.

Further program details and information on advance registration will be printed in the April issue of *Fire News* or may be obtained by writing the publication at 60 Batterymarch St., Boston 10, Mass.

Tour of VPI Campus Planned

A BUS tour of the Virginia Polytechnic Institute is being planned for members and friends of the American Society of Agricultural Engineers during the 1956 Annual Meeting to be held June 17 to 20 at Roanoke, Va.

The VPI campus is located 43 miles west of Roanoke in the Allegheny Mountains at an elevation of approximately 2100 ft in the town of Blacksburg. It was established in 1872 as a land-grant college on the site of the Drapers Meadow Massacre (Indian War) of 1755.

The college includes schools of agriculture, applied science, business administration and engineering. It includes also agricultural and engineering experiment stations and the agricultural extension service. A professional curriculum in agricultural engineering is offered and is accredited by the Engineers' Council for Professional Development. E. T. Swink is department head. An active and progressive student branch of ASAE is maintained.

The tour will cover the main campus with stops at Burruss Hall (administration and auditorium), the new Carol M. Newman Library, Randolph Hall (new mechanical engineering building) and the agricultural engineering building which will be named officially "Seitz Hall" at a brief ceremony during the tour. Agricultural teaching and research facilities will be pointed out from selected vantage points during the tour.

At conclusion of the campus tour there will be a period of relaxation at Squires Hall (student activity building) preceding dinner at Owens Hall. Immediately following dinner, the buses will return to Roanoke.

With the ASAE Sections

Pennsylvania Section

A meeting of the Pennsylvania Section will be held April 12 and 13 in the Hetzel Union Building (HUB), located on the Pennsylvania State University campus, University Park.

The program is scheduled to begin at 1:00 p.m., with registration to be completed before noon. Howard Bingham, New Way Farm Sales, Inc., will preside at the afternoon program. An activity report on Pennsylvania Farm Electrification Council will be given by Roy Smith, Metropolitan Edison Co., and a progress report on handling and processing grain on the farm will be presented by Ralph P. Prince, Pennsylvania State University. A panel on trends in merchandising specialty farm equipment by L. S. Singley, West Penn Power; D. C. Sprague, GLF Farm Supplies; and J. B. Stere, New Holland Machine Co., will follow. Papers on farm wiring improvement program by W. C. Wenner, Jr., Northwestern Rural Electric Co-op; some principles of flood prevention design by Joseph Bornstein, SCS, Upper Darby, Pa.; and design of irrigation systems by F. W. Peikert, head, agricultural engineering, Pennsylvania State University, will complete the first day program.

A Thursday evening banquet will be held at the Eutaw House, Potters Mills, Pa. Toastmaster will be B. P. Hess, Westinghouse Electric Corp.

On the Friday morning program will be papers on design of pole structures by John Walker, Pennsylvania State University; agricultural engineering in the future, speaker to be announced later; and forage crops and football by A. E. Cooper, Pennsylvania State University. A business meeting will follow. Adjournment is scheduled for 11:45 a.m.

Michigan Section

A meeting of the Michigan Section will be held at Dearborn Inn, Dearborn, on April 20. The program theme will be Management Engineering in Farm Practices. Harold E. Pinches, assistant director, farm and land management research, USDA, has been interested in the subject as a new branch for agricultural engineers and will start the meeting. His ideas have attracted attention as opportunities for employment and should be of interest to students and recent graduates interested in self-employment.

James Apple from the mechanical engineering department, Michigan State University, who specializes in industrial man-

(Continued on page 290)

J. Brownlee Davidson, charter member, honorary member, and first president of ASAE, and professor of agricultural engineering, Iowa State College, was one of five American engineers who were recently presented with Missouri Honor Awards for distinguished service in engineering by the University of Missouri at a special convocation on the program of the Centennial of Engineering Education at the University.

Dr. Davidson, a native of Nebraska, who holds B.S. degrees in mechanical and agricultural engineering and a doctor of engineering degree from the University of Nebraska, was cited for his "outstanding achievements in the field of agricultural engineering and engineering education."

He was lauded in the citation for his vision, leadership, and pioneer work in the application of engineering to agriculture, his service to the whole American economy in development of college instruction in agricultural engineering, and his promotion of high professional standards through his work in professional societies.

The Centennial celebration marks the one hundredth year since the first degrees in engineering were granted by the University of Missouri. Only 21 individuals and engineering corporations have received the Missouri Honor Awards since they were presented by the University and the Engineering Foundation in 1951.

George A. Crabb, Jr., has resigned as supervisor of the Michigan Hydrologic Research Station, Michigan State University, after nearly 20 years with the Agricultural Research Service, Soil Conservation Service, and Bureau of Public Roads, U.S. Department of Agriculture to accept a position as hydraulic engineer in the conservation bureau of the Portland Cement Association, Chicago.

Raymond C. Fischer has taken a position in the advanced engineering department of the McCormick Works of International Harvester Co., Chicago. Formerly he was supervisor of forward model implement product planning at Tractor and Implement Division, Ford Motor Co.

Ralph E. Patterson, has been promoted to a full professorship, and has been made chairman of the section of agricultural engineering extension, Pennsylvania State University. He fills a vacancy resulting from the resignation of Charles G. Burress in April, 1955.

Victor L. Hauser has returned from duty with the U.S. Army and is now enrolled as a graduate student at the University of California, Davis.

William D. Carpenter, recently released from military service, is now employed by the Aluminum Co. of America at the New Kensington Works, New Kensington, Pa., as an industrial engineer.

Leland O. Drew has resigned his position as associate professor of agricultural engineering, University of Georgia, to accept a position with the International Cooperation Administration as agricultural equipment advisor. He will begin a two-year tour of duty in Lebanon and will work under the leadership of Earle K. Rambo.

Kenneth W. Campen is employed as a trainee in the college graduate program of the Caterpillar Tractor Co., Peoria, Ill. Mr. Campen is a graduate from the University of Missouri.

ASAE MEMBERS in the News

J. B. DAVIDSON

R. P. MESSENGER

Robert P. Messenger, an ASAE member since 1920 and the 1955 recipient of the Cyrus Hall McCormick Medal retired on March 15 as executive vice-president of International Harvester Co., after more than 45 years with the company.

He began his career with Harvester in the engineering department of Springfield Works in 1910. He was sent to Europe in 1913 when the first overseas Harvester engineering department was organized. After World War I, he took charge of engineering and patent work in the Brussels Conference, and eventually became inspector general of engineering in Europe.

Even though, as a member of the American Society of Agricultural Engineers, it was impossible for him to share directly in the activities of the Society, his influence has been felt through his inspiration to other men to become members, and he took it upon himself to see that his company kept its Society membership and participation high.

In 1938 Mr. Messenger went to Australia where, as chairman of the board, he played a prominent part in the rapid growth and development of the Australian subsidiary company. He returned to the United States in 1942 to become assistant to the vice-president in charge of engineering, specializing in farm equipment engineering. He became the first general manager of the newly formed Farm Implement Division in 1944. He was elected vice-president in charge of that division in March, 1945.

In 1947 he became vice-president in charge of foreign operations, and in 1950 he was elected executive vice-president, retaining his supervision of foreign operations.

On February 21, 1952, he transferred his attention to the manufacturing, engineering, steel, and fiber and twine operations of the company, and continued to direct those activities until his retirement.

Mr. Messenger has announced that his future mailing address will be 9 Ivy Hill Road, Chappaqua, New York.

Amos M. Einerson has taken a position as development engineer with the Barnes Mfg. Co., Mansfield, Ohio. Previously he was manager of the sales engineering department of Krop-Kare Products Div., of Kilby Steel Co.

Charles A. Rollo has resigned his position at Tractor and Implement Division, Ford Motor Co., to accept the position recently vacated by Jimmy L. Butt at the Alabama Agricultural Experiment Station, Auburn.

Loyd Johnson returned recently from an assignment with the United Fruit Co. in Honduras and Guatemala, C.A. He is being transferred to the company's offices in Boston, Mass., where he will hold a position in the engineering department.

Charles M. Milne has returned from duty with the armed services and will attend Purdue University, Lafayette, Ind., for work toward a Ph.D. degree.

RESEARCH NOTES

Brief news notes and reports on research activities of special agricultural-engineering interest are invited for publication under this heading. These may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Michigan.

USDA Lister-Planter Attachment. Saving farmers of the Southwest subhumid areas millions of dollars annually in replanting costs is a lister-planter attachment developed by E. B. Hudspeth, Jr., AERB engineer of the Farm Machinery Section.

This attachment was largely responsible for the USDA Superior Service Award made to Mr. Hudspeth and reported in this column in June, 1955.

The device, which can be readily attached to a lister-type planter, features a narrow, shoe-type furrow opener that permits seed to fall to the firm bottom of the furrow. The side shields of this opener extend back to a hollow, soft rubber-tired press wheel which presses the seeds into the firm, moist soil before they are covered. A covering device follows which covers the seeds at an optimum depth of 1½ in. The combination of pressing the seeds into moist soil and the light covering of earth over them makes it easier for seedlings to push through a crust that might form.

Use of Mr. Hudspeth's attachment is increasing with fully 15,000 units in operation in 1955. The development is making possible a new planting practice that insures better stands, avoids replanting, and is replacing the old practice common to the Southwest of planting 3 to 4 in deep.

Developments of the attachment have taken place largely since 1951 and are reported in Texas Agricultural Experiment Station's Progress Reports Nos. 1415, 1484, 1547, 1673, and 1688.

Acknowledgments. AERB engineers, Charles A. Bennett and Charles M. Merkel, and cotton technologist Vernon P. Moore, of the Mechanical Preparation and Conditioning Section, stationed at Stoneville, Miss., have been given acknowledgments of appreciation for research work in cotton ginning and technology by the Arkansas-Missouri Cotton Ginners Assn., publishers of the "Cotton Ginner's Handbook."

Mr. Bennett is in charge of the over-all cotton ginning research projects being conducted by USDA cotton research laboratories at Stoneville, Miss., Mesilla Park, N. M., and in cooperation with the Oklahoma Agricultural Experiment Station at Chickasha. He will also supervise the work to be done at the new U.S. Cotton Ginning Research Laboratory at Clemson, S. C.

Mr. Merkel is engineer in charge of the Stoneville laboratory and Mr. Moore has technical supervision of all fiber-quality evaluation work in connection with the cotton-ginning investigations project.

For many implements, leading manufacturers

switch to "AG" roller chain

without altering design, sprockets or performance

Corn picking is one of the tougher services chain encounters in the implement field, and John Deere uses Link-Belt "AG" chain for its Two-Row Mounted Picker. Besides F attachment shown, others are available for specific conveying jobs.

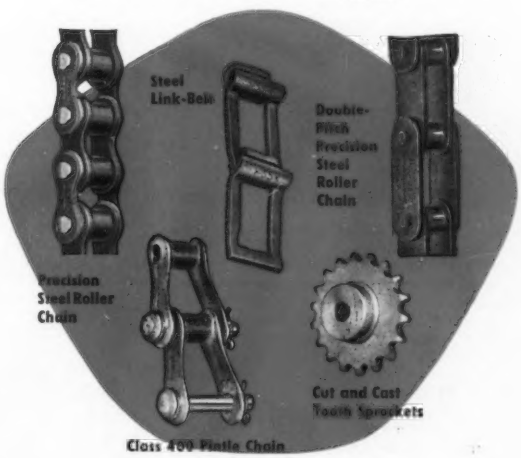
There may be a place for this economical LINK-BELT chain on your equipment, too

There are thousands of farm machines manufactured today that could achieve their efficiency at lower cost with Link-Belt "AG" Roller Chain. It intercouples and is interchangeable with ASA double pitch roller chain and is built with the same durability.

This widely accepted chain offers many of the manufacturing extras that make Link-Belt Precision Steel Roller Chain outstanding. Maximum wear-life is assured by uniform heat treatment of parts and controlled press fits. Also retained is the *lock-type bushing* feature—Link-Belt's successful answer to a common cause of joint stiffness.

"AG" chain is available in 1", 1¼" and 1½" pitches, with straight or relieved sidebars for conveying or transmitting power. For information on this or Link-Belt double pitch precision steel roller chain, call the Link-Belt office near you.

Looking for the BEST chain for a specific need?
LINK-BELT makes the complete line



LINK-BELT

CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

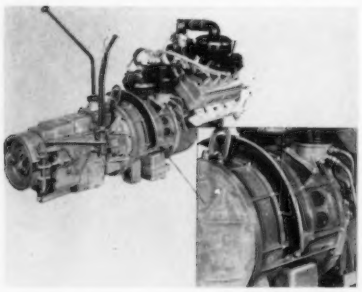
13,959

NEW PRODUCTS CATALOGS

Lightweight Torque Converter

Chrysler Corp., Industrial Engine Division, 2000 Van Horn Rd., Trenton, Mich., has introduced a new torque converter which features low initial cost and lightweight—actually about two-thirds the weight of regular units due to its construction of cast aluminum alloy.

It is said to be adaptable to any type of equipment and is factory-equipped for transmission and power take-off. Coupling efficiency is handled automatically and when torque demand falls off due to load diminishing, the converter enters a coupling range where it is said to reach almost 97 percent efficiency.



Heat dissipation is carried out through dual cooling systems, both liquid and direct air. As optional equipment, an output shaft governor provides instant response to variations in road and load conditions. Torque multiplication is listed as 2.6.

Shown is the Model 56, 331 cu in, V-8 industrial engine equipped with the new torque converter and five-speed transmission. Torque converter is shown in inset.

Self-Propelled Windrower

International Harvester Co., 180 N. Michigan Ave., Chicago 1, Ill., has announced a new self-propelled windrower featuring a low-angled platform. The center-delivery platform of the new windrower has a maximum working angle of only 23 deg when set at its lowest cutting height. The angle becomes even smaller as the platform is raised. The low-angle, center-delivery design of the platform is said to interlace stems of the crop being windrowed into a uniform fluffy pattern, whereby the windrow is supported to a large extent by the stubble.

A one-lever hydraulic control permits the operator to raise and lower the reel alone, or the reel and platform at the same time. All of the operating controls are located in an easy-to-reach position.

Two steering levers, located directly in front of the operator, control the planetary gear drive. A foot pedal controls the variable-speed drive to change speeds on the go. This offers a selection of seven travel speeds by simply touching the foot pedal. The windrower is available with a 12 or 16-ft platform and a 25-hp air-cooled or 30-hp water-cooled, heavy-duty engine.

New Short-Stroke Engine

Kohler Co., Kohler, Wis., has introduced a new short-stroke, air-cooled gasoline engine designed for heavy-duty farm, construction, and industrial applications.

Designated as the K330, the new engine delivers 12.5 hp at 3200 rpm. It is a single-cylinder, 4-cycle, air-cooled engine equipped with flyweight governor, oil-bath air cleaner, silencer-type muffler, fuel pump, oil pressure gage, exhaust valve insert and exhaust valve rotator. It will be made available also in a number of optional models that will include direct mounting crankcase, reduction gear, hand clutch, and electric starter and generator. Foot pounds of torque range from 23.8 at 1800 rpm to 20.3 at 3200 rpm. The bore is 3⅜ in, the stroke 3¼ in and the piston displacement is 33.6 cu in.

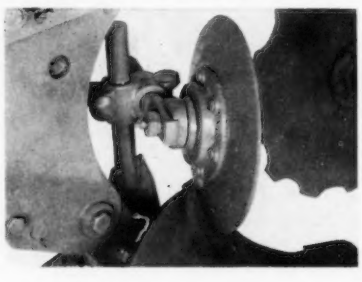
New All-Purpose Hose

Manhattan Rubber Division, Raybestos-Manhattan, Inc., Passaic, N. J., has announced a new type of all-purpose hose, described as suitable for use with air, oil, water and mild chemicals. The new hose is being marketed under the trade name "Allflex."

Allflex is said to possess extremely long life and is non-kinking. It is the newest addition to the R/M line of hose, and the first all-purpose hose of mandrel-made, horizontal braided construction. For more complete information, write the company for Bulletin No. 7075.

Cover Disks for Moldboard Plows

Deere and Co., Moline, Ill., has introduced new cover disks for attaching on truss-frame moldboard plows. These new disks are designed to turn trash and the leading edge of the furrow slice after the slice has been lifted and partially inverted. The manufacturer reports that the cover disks do not hinder penetration and cause no appreciable difference in plow draft.



Tractor-Mounted Disk Harrow

Allis-Chalmers Mfg. Co., Farm Equipment Division, Milwaukee, Wis., has added an 8½-ft double-action tractor-mounted disk harrow to its farm implement line. It is matched to the company's WD-45 and WD tractors.

The new disk harrow is available with either 28 16-in smooth disk blades front and rear, or with 14 18-in cutaway disk blades front and the same number and size smooth disk blades rear. The blades are of heavy-duty heat-treated steel.

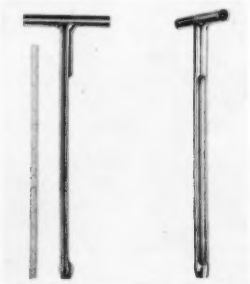
This new disk features a flexible "backbone" frame member. This provides a semi-rigid harrow, yet permits the entire frame to flex when disking over uneven ground. Other features include 1-in diameter gang bolts; forged bumper plates on the front gangs and greased-for-life bearings. A crank-adjusted screw enables the operator to increase or decrease penetration of front or rear gangs from the tractor seat. All four gangs are adjustable independently of each other.

Ring Insert Folder

Reader Service Section, The International Nickel Co., Inc., 67 Wall St., New York 5, N. Y., has released a new 4-page folder entitled, "Keep Them Rolling." The illustrated folder explains what piston-ring-groove inserts are, how they affect efficiency and the life of aluminum pistons, and the use of Ni-Resist austenitic iron in the construction of these inserts.

Soil Profile Sampler

Elano Corp., Xenia, Ohio, has introduced a new soil sampler for providing soil samples with undistorted cores. The basic features are a probe cup with a heat-treated cutting tip that resists blunting, bending or twisting. This cup is machine drawn from the main tube in such a manner that it cuts a soil core slightly smaller than the tube itself. This is said to permit the core to rise in the tube without breaking.



Open-side construction of this sampler makes it handy to obtain an on-the-spot analysis of the soil at various depths without removing the core from the tool. The surface of the entire sampler tool is chrome plated. It is corrosion resistant and easy to clean after use.

(Continued on page 272)

A report to you about men and machines that help maintain International Harvester leadership

UTILITY UNLIMITED

means SALES OPPORTUNITY UNLIMITED for IH dealers

Now! POWER STEERING gives the New International® 300 Utility still greater all-job leadership!

Both on the farm and off the farm, the new International 300 Utility is pacing its field in ability to step up output and cut downtime—with its basic advantage of greater built-in weight for unmatched traction and stamina. Additional features such as TA, completely independent pto, Fast-Hitch and Hydra-Touch add still more to job adaptability.

Now, integral power steering—another field-leading option! The result: a still wider circle of prospects for IH dealers, to step up sales volume in 1956!

With IH power steering, the operator can maneuver the 300 Utility single-handed, keeping the other hand free to control equipment *on the go!*

Utility unlimited! Both McCormick® and special duty equipment—Fast-Hitch or mounted—are available.

A tractor for EVERY prospect! With the versatile new 300 Utility added to the complete line of Farmall, Standard Wheel and Crawler tractors—more than ever the IH franchise means *sales opportunity unlimited* to IH dealers.

INTERNATIONAL HARVESTER

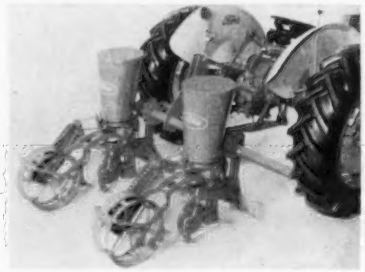
International Harvester products pay for themselves in use—McCormick Farm Equipment and Farmall Tractors... Motor Trucks... Crawler and Utility Tractors and Power Units—General Office, Chicago 1, Illinois.

New Products and Catalogs

(Continued from page 270)

Tool Bar Attachments

Tractor and Implement Division, Ford Motor Co., Birmingham, Mich., has announced a new two-row lister planter as one of several combinations available in the new line of tool bars and attachments. The tool bars are available in two, three and



four-row lengths and are designed to mount on all Ford and Fordson Major diesel tractors. Equipment includes eight types of bottoms for middlebusting, listing and bed planting, as well as a wide variety of planting attachments.

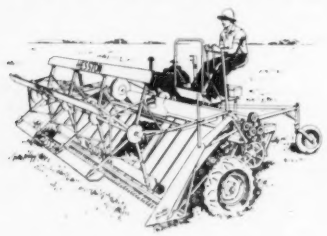
Improved Starter for Diesels

Caterpillar Tractor Co., Peoria, Ill., has announced the use of improved direct electric-starting systems as attachments for D6, D4 and D2 tractors and No. 977, No. 955 and No. 933 Traxcavators.

Each of the 24-volt systems now includes as standard equipment two ether starting aids and the necessary tubing to inject vaporized ether into the air intake manifold. The company states that the use of the ether starting aids in conjunction with the glow plugs which have been used for some time makes it possible to start without difficulty in temperatures as low as 10 F.

Self-Propelled Swather

Hesston Mfg. Co., Inc., Hesston, Kans., has announced a new self-propelled swather designed to leave uniformly criss-crossed

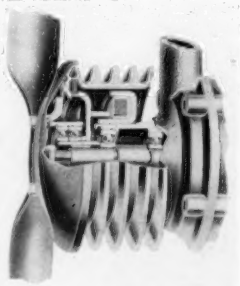


heads on top of the swath for uniform drying. Operation is through a V-belt arrangement that is easy to service or adjust, and allows operator to cut square corners. There is a multiple-speed reel adjustment for all conditions.

Electric Clutch Controls Engine Fan

Warner Electric Brake & Clutch Co., Beloit, Wis., has announced the development of a new electric fan-clutch unit for internal-combustion engines. The new clutch provides a means of disengaging the fan from its pulley when operating conditions make the fan unnecessary.

In operation the new clutch control can be adapted equally well to engines which carry the fan and water pump on the same shaft driven by a common pulley, or to engines on which the fan is separate from the water pump. A typical application utilizes an electric clutch of stationary-field design with the field mounted on the water pump housing. The sheave and rotor are fastened together and mounted in such a way as to



drive the shaft continuously. In this way the water-pump impeller rotates constantly. A hub is mounted on bearings in front of the rotor with an armature fixed to the hub with leaf springs so that it runs normally with a small clearance between its face and the rotor face. The fan is bolted to the front of the hub. When the coil is energized, magnetic pull at the rotor pole faces attracts the armature and holds it to the rotating rotor. The hub and fan are then driven with the pulley. This clutch is generally set up so that a thermostatic switch may be used to control it. This thermostat is located so it can be actuated by a change in temperature of the water system in order to cycle the fan clutch on and off as required.

The extremely wide variations in engine design make it necessary to design a fan clutch for each engine in order to meet specific requirements. Information on specific application arrangements may be obtained from the manufacturer.

Zig-Zag Coulter Blade

Lantz Mfg. Co., Valparaiso, Ind., has announced its new zig-zag "Til-Kut" blade to fit standard plow coulters. They may be had for Cockshutt, John Deere, M-M, A-C, IH, Case, Oliver, M-H-F, Ford and all Lantz coulter models. The new blade is designed to grip stalks and trash and cut with a chewing action to reduce plow plugging. The blade loosens the soil next to the blade, permitting the jointer to run in loosened soil. The zig-zag edge also helps prevent slippage and provides more steady, continuous rotation of the coulter blade, it is said.

Weigher and Sampler for Pipeline Milkers

Babson Bros. Co., 2843 W. 19th St., Chicago 23, Ill., has developed a new stainless steel weighing device for weighing and test sampling each cow's production in pipeline milking systems. The non-breakable device hangs on scales with one hose

connected to the breaker cup and the other to the main milkline. Weight of the milk collected in the bucket is read on scales that register up to 60 lb. Then the weighpail is tipped and milk flows into the main milkline automatically.

A sampling device with a Y-nipple collects a uniform drop-by-drop sample of milk as it moves past.

New Line of Sprayers

John Bean, Division of Food Machinery and Chemical Corp., Lansing, Mich., has announced a new complete line of tractor or trailer-mounted sprayers. Interchangeability of component parts—pumps, barrel mounts, and matching cut-off valves and hose sets—permits the user to make up a rig suited to his particular requirements.

The three barrel-mount kits, designed for quick attachment, include a rear-mounted standard for tractors with stationary hitch,

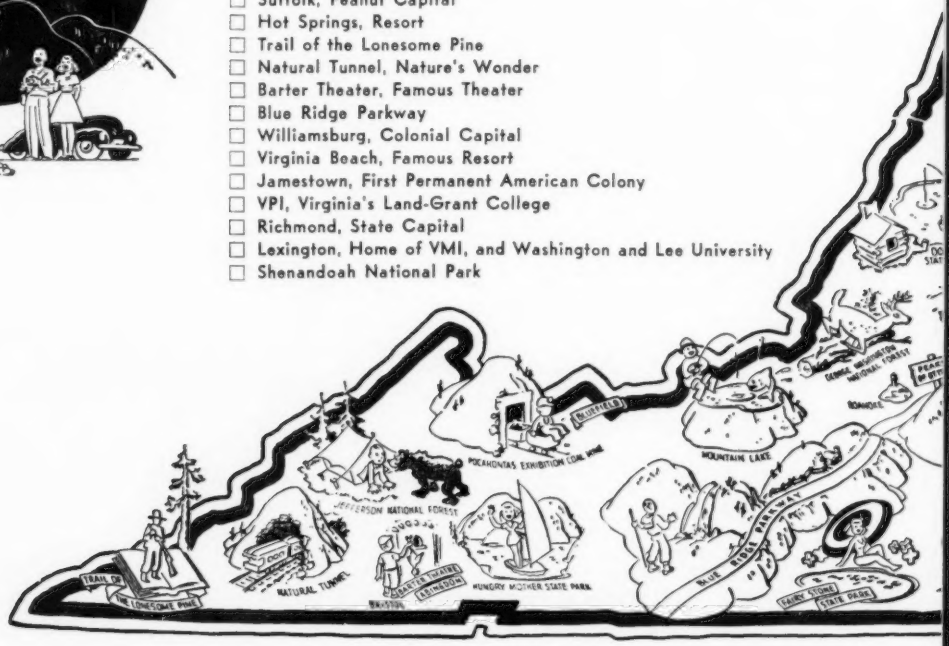
one for tractors with 3-point hydraulic lift, and a high-clearance mounting that allows the user to cultivate as he sprays. All kits include necessary hooks, bolts, and chains for mounting.

The trailer-mounted sprayers can be used with two 55-gal drums or a factory-equipped 150-gal steel tank. A 160-gal aluminum tank is available for use with liquid fertilizers. Wheel treads on the trailer are adjustable from 72 to 84 in. Wheels take standard 15-in tires.

In all, there are twelve completely different models. Pump kits are complete with coupling for mounting directly on the tractor PTO shaft. The duoflex boom has 13 nozzles, spaced 20 in apart and will cover a 21 ft, 8 in swath. The 4-way hinges allow wings to spring upon striking an obstacle. All controls mount handy to the tractor seat. *(Continued on page 278)*

CHECK THE PLACES YOU WOULD LIKE TO SEE IN VIRGINIA

- ☐ Roanoke, ASAE 1956 Annual Meeting
- ☐ Mount Vernon, Washington's Home
- ☐ Wakefield, Washington's Birthplace
- ☐ Stratford, Lee's Birthplace
- ☐ Yorktown, Revolutionary War Shrine
- ☐ Monticello, Jefferson's Home
- ☐ Skyline Drive, Scenic Highway
- ☐ Caverns, Underground Wonders
- ☐ Appomattox, Civil War Surrender
- ☐ Natural Bridge, World's Natural Wonder
- ☐ Mountain Lake, Mountain Resort
- ☐ Suffolk, Peanut Capital
- ☐ Hot Springs, Resort
- ☐ Trail of the Lonesome Pine
- ☐ Natural Tunnel, Nature's Wonder
- ☐ Barter Theater, Famous Theater
- ☐ Blue Ridge Parkway
- ☐ Williamsburg, Colonial Capital
- ☐ Virginia Beach, Famous Resort
- ☐ Jamestown, First Permanent American Colony
- ☐ VPI, Virginia's Land-Grant College
- ☐ Richmond, State Capital
- ☐ Lexington, Home of VMI, and Washington and Lee University
- ☐ Shenandoah National Park



VIRGINIA **. . . "The Old Dominion" . . . Better Known fo**

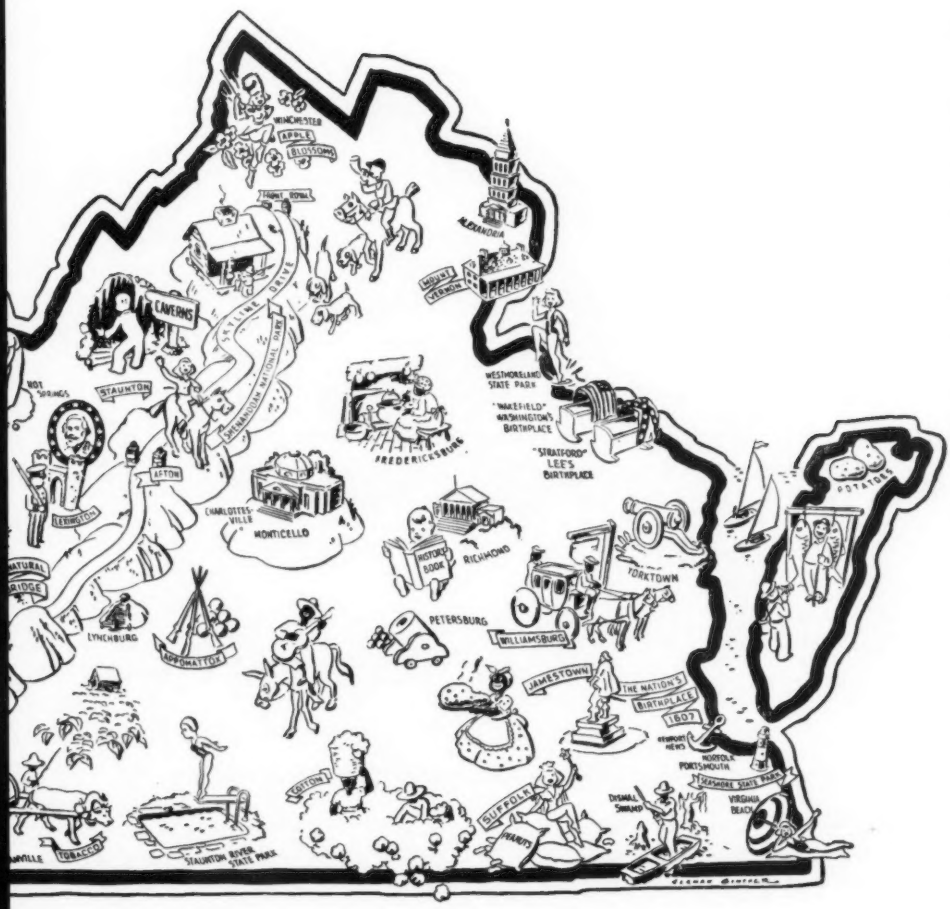
A MODERN
AIR-CONDITIONED
· · VERSION · ·
of an
OLD ENGLISH
INN

Hotel Roanoke — Headquarters for the 1956 ASAE Annual Meeting

SOME FAMOUS NAMES IN VIRGINIA AND UNITED STATES HISTORY

George Washington
Thomas Jefferson
James Madison
James Monroe
William Henry Harrison
John Tyler
Zachary Taylor
Woodrow Wilson

Pocahontas
Sir John Smith
George Mason
Patrick Henry
John Marshall
Cyrus Hall McCormick
Matthew Fontaine Maury
William Byrd of Westover
Robert E. Lee
Carter Glass



Historic Shrines, Scenic Attractions, and Natural Wonders

INVITES YOU TO ATTEND THE

49th ANNUAL ASAE MEETING

HOTEL ROANOKE

ROANOKE, VIRGINIA

JUNE 17-20, 1956

Come to Virginia and bring the family for a Vacation

Waiting on livestock beats self-service grazing

Nowadays turning livestock loose to graze and help themselves may be a costly luxury—where the land is under intensive cultivation.

Many farmers are carrying fresh-cut grass to their livestock *daily*. This is Green Feeding—also known as Soilage, Mechanical Grazing and Zero Pasture.

Green Feeding is the best system *so far* for getting highest productivity per acre of grassland. Feed costs are lowest. More stock can be carried per acre. Or parts of present acreage can be turned to other crops.

How are costs cut? Most farmers agree that grazing wastes a part of the grass in pasture. Estimates go all the way to 25%. Green Feeding eliminates the cause of this waste. Lush early-season forage is not wasted by trampling or animals lying down. And no urine or manure spots which stock avoid.

There is no undergrazing. Some cows get so smart on rotation that they simply top the new grass and bellow to be let into the next field. With Green Feeding they eat every bit, leaves and stems, and the need for supplemental grains and concentrates is held down. There is no overgrazing either. Soil compaction is reduced and plants are not loosened or torn up.

The backbone of a Green Feeding system is the *forage harvester*. You cut and chop the daily ration and feed it directly. The expenses involved—labor, machinery, depreciation, gas and oil—must, of course, be figured against production gains.

New Holland's Forage Harvester with direct-cut attachment chops and loads up to 22 tons of standing forage crops per hour. This hard-working, high-speed harvester is just one of the new and improved grassland machines produced by New Holland to make developments, like Green Feeding, practical.

New Holland Machine Co., New Holland, Pa.

NEW HOLLAND

"First in Grassland Farming"

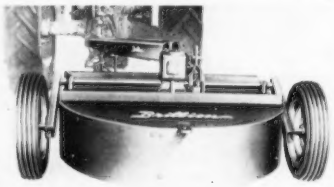
New Products and Catalogs

(Continued from page 272)

Adds to Rotary Shredder Line

Brillion Iron Works, Brillion, Wis., has announced a new shredder, designed specifically for orchard operations and featuring a swinging drawbar that permits a 2-ft offset.

Using direct drive, the shredder can be used as either a straight-pull or offset unit. The offset feature is particularly helpful to the orchard grower who desires to shred



prunings or clip grass and weeds under trees. The offset drawbar can be added to any of the company's shredders by use of a conversion kit.

Also announced is a new standard model rotary shredder that can be raised and lowered hydraulically through 3-point tractor hitches. The pickup unit contains all of the features of the regular shredder line and is offered with either a 1⅛ or 1⅜-in spline on the PTO shaft. Cutting width is 5 ft.

Handyman Handbook

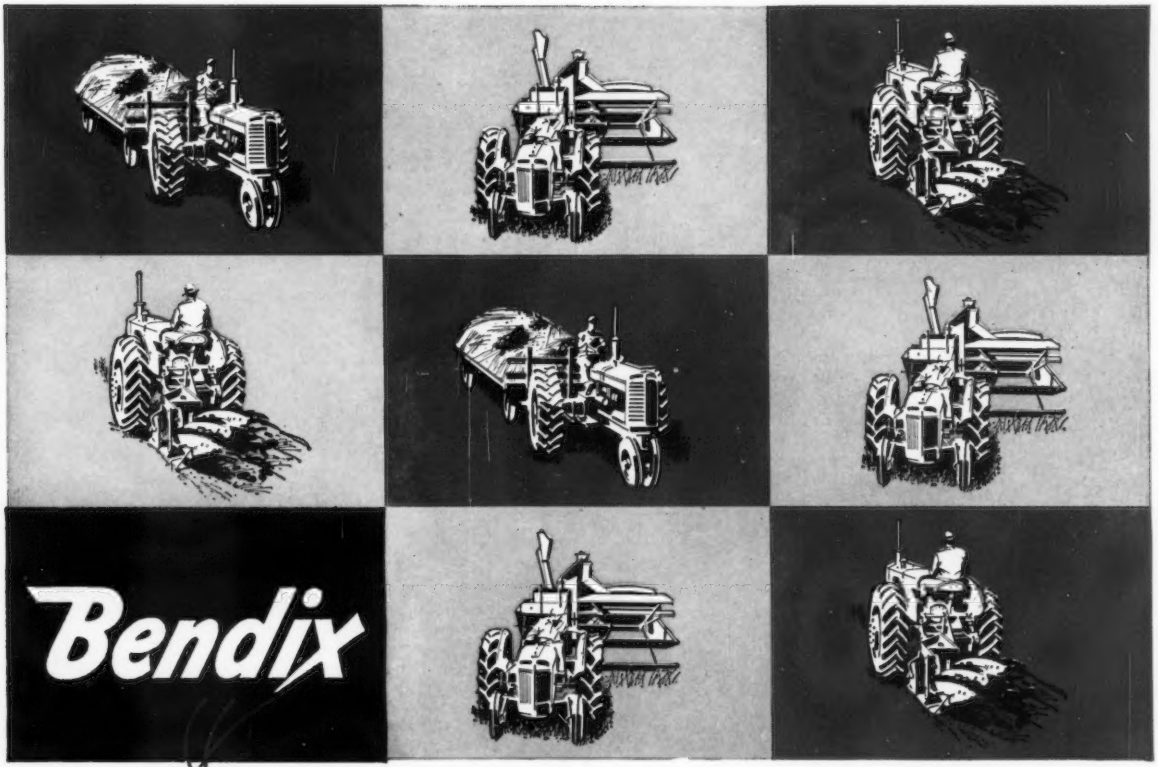
Home Service Bureau, Masonite Corp., 111 West Washington St., Chicago 2, Ill., will send free on request a 12-page illustrated handbook telling where and how to use the company's products. Data is given on products in the line and their common uses, do's and don'ts in handling, joint treatments, installation of peg-board panels, shelf construction, interior partitions, cabinet and door construction. Twenty free plans are listed.

Self-Propelled Baler

Minneapolis-Moline Co., Box 1050, Minneapolis 1, Minn., has added a hay baler to its group of self-propelled farm machines. The baler brings to six the number of machines which can be mounted interchangeably on a basic power unit.

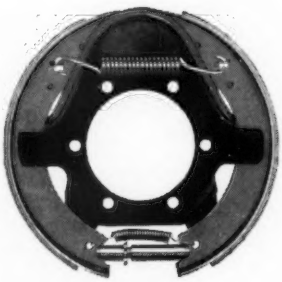
The baler has an over-all width of 5 ft; is 12 ft, 8 in long unmounted, and 15 ft, 8 in

when mounted; 5 ft, 4 in in height; and weighs 2290 lb. It features straight-through design; stainless steel knotting jaws and bills; internal auger greaseless bearings; and compact design. The plunger travels in a short arc, dropping below the packing chamber to allow the hay to move in unimpeded flow from pick-up to bale, and then rising to pack the sliced hay. Bales are square-cornered and 14x18 in. The five-bar pick-up drum is 4 ft wide, and has a diameter of 16 in. *(Continued on page 280)*



Farm Tractor Brakes...

backed by the greatest name in braking



The Bendix heavy-duty farm tractor brake has powerful and positive holding action in both forward and reverse. Rugged design assures uniform performance day after day, under the most severe field and road work.

For 25 years Bendix has specialized in building brakes for the automotive industry. In that period of time the Bendix Products Division at South Bend has built more than 90 million brakes for passenger cars, trucks and farm tractors.

These are reasons why tractor manufacturers—as well as passenger car and truck manufacturers—look to Bendix as brake headquarters.

Bendix Brakes for farm tractors are specifically designed for the exacting needs of this class of service, combining rugged, dependable and smooth action with low cost. That's why Bendix Brakes are the logical choice for the modern tractor.

Let Bendix farm tractor brake engineers help you solve your brake problems. Write for detailed information.*

*REG. U.S. PAT. OFF.

BENDIX • PRODUCTS DIVISION • SOUTH BEND Bendix AVIATION CORPORATION

EXPORT SALES:

Bendix International Division, 205 East 42nd St., New York 17, N. Y. • Canadian Sales: Bendix-Eclipse of Canada, Ltd., Windsor, Ontario, Canada

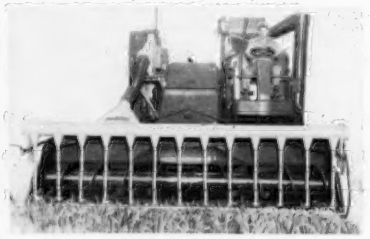
New Products and Catalogs

(Continued from page 278)

Blower Replaces Combine Reel

Wind-Reel Div., Dunbar Kapple, Inc., Geneva, Ill., has announced production of a wind-reel attachment for combine harvesters.

The new attachment consists of a blower powered from the combine, a large hori-



zontal headpipe, and a series of smaller vertical pipes which terminate close to the ground in front of the cutter bar. Air blasts force the grain into the cutter bar and then onto the auger platform. Grain will not blow or fall off the combine platform even on windy days, it is said. The company states that savings in grain up to 10 bu per acre have been reported.

New Product Book

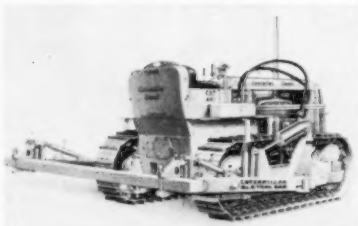
Long Mfg. Division, Borg-Warner Corp., 12501 DeQuindre St., Detroit 12, Mich., has published a 20-page book giving information on products of its manunfacture, copies of which are available to readers on request to the company.

The new publication describes and illustrates torque converters, radiators, clutches, oil coolers, heat exchanger coils and components for air conditioning manufactured by the division. The book also explains the division's research, development engineering and manufacturing facilities. It includes photographs of plant operations, as well as drawings and prints of products and product design.

Tool Bar and Dozer Arrangement

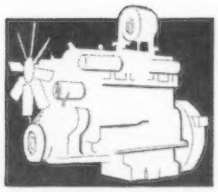
Caterpillar Tractor Co., Peoria, Ill., has announced a new No. 6 tool bar and tool bar bulldozer arrangement for its D6 tractor.

The unit features the same type of swing-around draft members as the No. 2 and



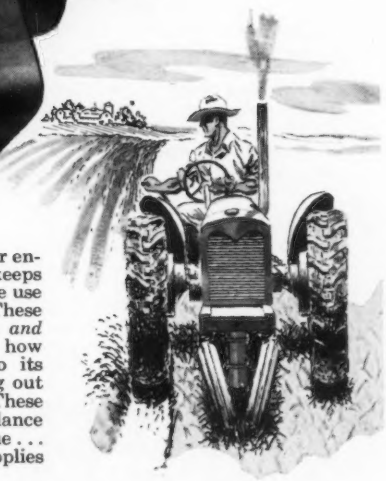
No. 4 tool bars introduced recently. Adjusting screws provide a tip-tilt feature to the dozer blade, making ditch building and cleaning easier.

Quick disconnect beam clamps for beam changes and the welded box section 4½ x 7½-in beam which provides mounting for deep-tillage tools, are other features on the new attachment. The hydraulic cylinders used on the No. 6 are double-acting and can be used for operating other agricultural implements when the tool bar is not being used. *(Continued on page 282)*



For every engine, there's a VEEDER-ROOT REV-COUNTER

to prove your product's claims



Rev-Counter for general built-in use. Self-contained case is designed for outside application.

Rev-Counter especially designed for installation in user's housing.

Rev-Counter especially designed for built-in installations.

That's right . . . you can build into your engine a real "performance-prover" that keeps a faithful and complete record of engine use . . . a record that's beyond dispute. These Veeder-Root Rev-Counters *show you and your customers*, at any time, exactly how your equipment is performing up to its guarantee . . . whether thev're getting out of it all the service you built into it. These direct counter-readings also show at a glance when routine maintenance is coming due . . . whether servicing is needed . . . and supplies other valuable facts-in-figures.

This 2-way protection is vital not only as a built-in feature of engines, but also of generators, compressors, heaters, refrigerators, high-speed cameras, and what have *you?*

Veeder-Root Rev-Counters are available with *tachometer take-off* . . . and may be geared to your own engine requirements. Count on Veeder-Root for any assistance you need in designing these Rev-Counters into your product. Write:

VEEDER-ROOT INC., Hartford 2, Conn.

STOCKS OF STANDARD COUNTERS AVAILABLE AT

Greenville, S. C. • Chicago 6, Ill. • New York 19, N. Y. • Los Angeles • San Francisco • Montreal 2, Canada • Offices and Agents in Other Principal Cities

Everyone Can Count on

VEEDER-ROOT

"The Name that Counts"

ADVANTAGES OF FLEXIBLE SHAFTING for Power Drive and Remote Control

by C. HOTCHKISS, JR.

Application Engineer,

Stow Manufacturing Company

Flexible shafting has the following advantages over other type drives:

1 – It is often the simplest method of transmitting power between two points which are not collinear or which have relative motion

2 – eliminates exposed revolving parts

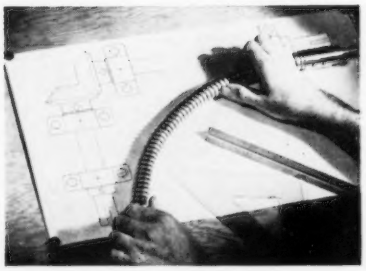
3 – does not require accurate alignment

4 – easy to install and maintain.

NOT COLLINEAR – Where it is necessary to connect two shafts which are not collinear, a simple arrangement of a single belt or two universal joints will often do the job adequately. But, in many cases where the path of transmission is more complicated and would require a more expensive arrangement of mechanical components, flexible shafting provides a simple, low cost, efficient drive which is easy to install because it does not require accurate alignment. See example, figure 1, in which a 1¼-inch Stow flexible shaft is used to drive the auger on a G.L.F. bulk feed truck.

Flexible shafting also allows the designer greater freedom in locating either the drive or the driven component on a piece of equipment.

Fig. 1



RELATIVE MOTION—Where two shafts which have relative motion must be connected, flexible shafting is often the ideal means of transmission. In many cases it eliminates a much more complicated drive which would, necessarily, include telescopic joints; further, it eliminates the danger of exposed moving parts. See figure 2, which shows a ¾-inch Stow flexible shaft driving an Avery Rake built by the Minneapolis Moline Co.

Fig. 2

Other typical applications of this type are used on portable power tools when motors are too heavy to be mounted on the tool—such as portable grinders, sanders, paint scrapers, saws and tree tappers. And, since flexible shafting is not affected by vibration, it is an ideal drive for applications where a high degree of vibration is involved —such as in vibration testing tables and concrete vibrators.

Stow flexible shafts are available: for power drive applications in diameter sizes from ⅛ inch to 1¼ inches; for remote control applications in diameter sizes from ⅛ inch to 1⅝ inches.

The 1¼ inch power drive shaft will transmit up to 10 HP while the 1⅝ inch remote control shaft will transmit up to 4000 lb. in.

For complete engineering data on flexible shafting, including selection charts, write for engineering bulletin 525.

STOW MANUFACTURING COMPANY

39 SHEAR STREET • BINGHAMTON, NEW YORK

New Products and Catalogs

(Continued from page 280)

Nozzle Cluster for Boomless Sprayers

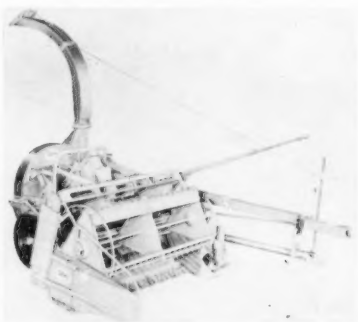
Hanson Equipment Co., Beloit, Wis., has developed a new automatic nozzle cluster for boomless sprayers. The device is designed specifically for windy-day spraying when adverse sidewind conditions would in-

terrupt regular spraying operations. The new unit takes advantage of the sidewind by always spraying with it. It offers spray swaths up to 40 ft wide.

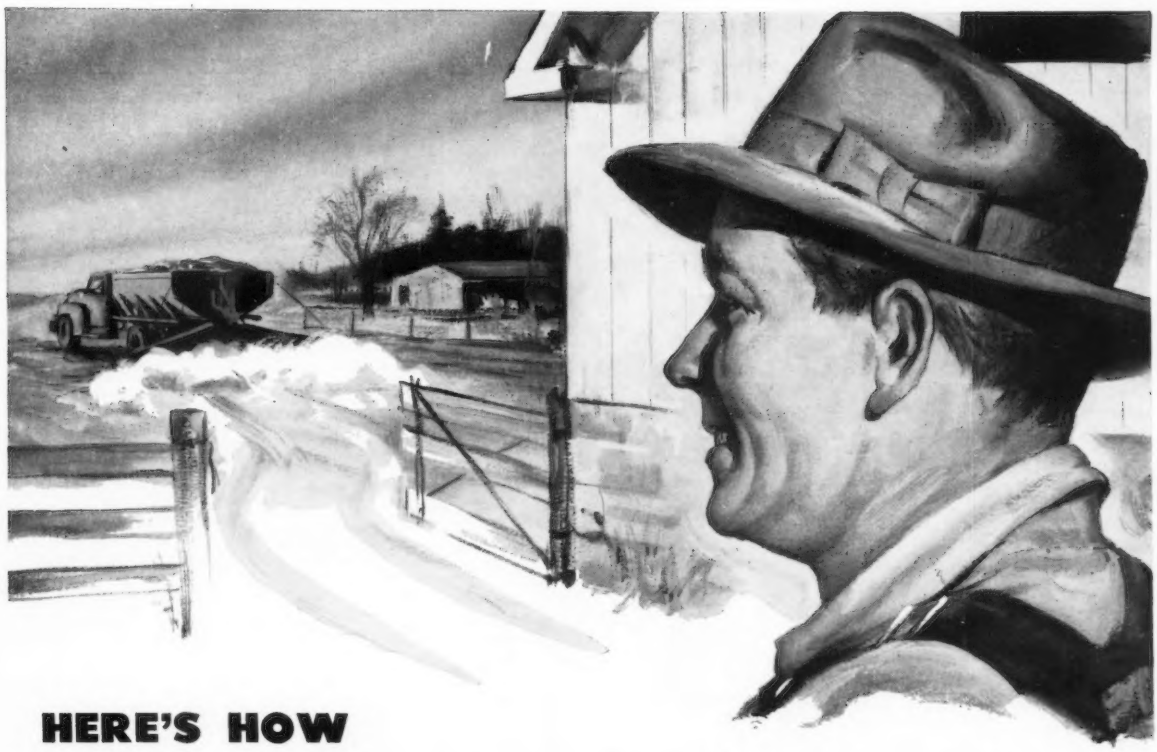
Spraying operations begin in the first field run by spraying to the side of the tractor with the wind. At the end of each field run, the operator merely turns off his sprayer, positions his tractor for the next field run and turns his sprayer on again. A valve mechanism within the cluster automatically reverses the flow of liquid by shutting off one nozzle while opening the other. Thus the spray swath is always projected to the side of the tractor that is with the wind.

New Mower Bar Attachment

Gehl Bros. Mfg. Co., West Bend, Wis., has announced that its Chop-All harvester is available with either a 5 or 6-ft mower bar. The new mower bar is equipped with feeder arms at the side of the packer roller to

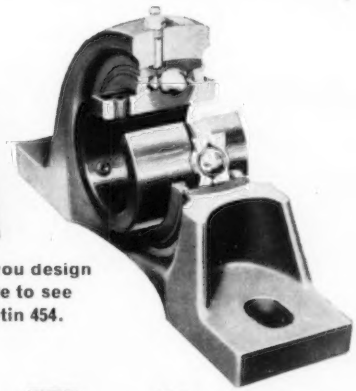


provide even continuous feeding under all crop conditions. For extremely rank, tall crops, a pusher bar can be mounted in front of the reel. It takes but a few minutes to change from the mower-bar attachments to the hay pick-up, or the one or two-row attachments. The mower bars bring to five the number of attachments available for the Gehl harvester.*(Continued on page 284)*



HERE'S HOW SEALMASTER HELPS YOU TO SERVE HIM BETTER

Before you design be sure to see Bulletin 454.



Throughout the farm machinery industry, engineers are busy designing new and better machines, not only to make the U. S. farmer's job easier but more efficient and profitable. Replacement sales bear out the fact that the farmer wants more than a rolling, clanking machine to get him by. He is well aware of the cost of maintenance and work stoppages and has become increasingly quality conscious. He looks beyond the trim design and brightly painted exterior into the "guts" of the machinery. The bearings are an important checkpoint in his search for quality. SEALMASTER Bearings have become synonymous with quality in farm machinery. Patented SEALMASTER features like Zone Hardening, Floating Ball Retainer, Locking Pin & Perimeter Dimple and Labyrinth Seal assure maximum performance and smooth power transmission. Find out today what they mean to you in customer satisfaction and repeat sales.

SEALMASTER BEARINGS A DIVISION OF STEPHENS-ADAMSON MFG. CO., 67 RIDGEWAY AVENUE, AURORA, ILLINOIS

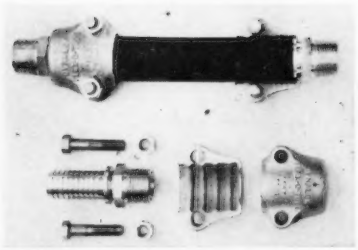
New Products and Catalogs

(Continued from page 282)

Hydraulic Hose Fittings

Flex-O-Tube Division, Meridan Corp., 2525 Jim Daly Road, Inkster, Mich., has announced a newly designed and engineered push-on fitting for low-pressure use on machine tools or for shop air, water, fuel, or lubrication lines, and a special two-bolt clamp fitting for high-pressure, heavy-duty applications for hydraulic lines, steam hoses or liquid petroleum gas transmission.

The push-on fitting is brass, comes in ¼, ⅜, and ½-in sizes, and is designed for use with a rubber-covered hose for a wide variety of low-pressure uses up to 250 psi. The new fitting can be assembled dry or



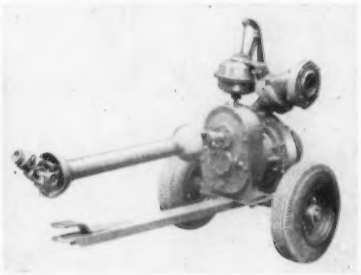
with water as a lubricant merely by pushing the hose over twin ferrules on the fitting stem.

The new clamp fitting (shown) is made of heavy malleable iron and is secured by two large heat-treated bolts. It is also a reusable fitting and has the feature of swift hose replacement by leaving the fitting on a machine and inserting the new hose over the fitting stem. The clamp fitting is made in eight sizes to accommodate hose from ¼ to 2 in in diameter and pressures up to 3,000 psi.

PTO Speed-Increaser Pumps

The Ralph B. Carter Co., 192 Atlantic St., Hackensack, N. J., has announced an entirely new speed-increaser line of irrigation pumps designed for power take-off drives.

These new centrifugal pressure pumps feature an integral speed increaser gear box



which also serves as an oversized oil retainer and housing. By utilizing this oil immersion arrangement, it eliminates the need for auxiliary water cooling. The internal gearing system is coupled to the shaft by helical cut gears. Ball bearings support the telescopic drive shaft which fits all standard tractor power take-off stubs.

Pumps are available in 3 and 4-in sizes, for a capacity range of 150 to 800 gpm and pressures up to 115 psi.

Elevator Features Add-To Design

Portable Elevator Mfg. Co., 920 E. Grove St., Bloomington, Ill., has introduced a new 21-in width elevator designed for handling all crops. The new elevator comes in 26,

32, 38 and 44-ft lengths. Extensions in 6-ft sections up to 44 ft can be obtained at any time within one year without price penalty. The only price paid is the difference in list price between the elevator first bought and the length elevator wanted. Raising and lowering are accomplished by a self-braking windlass with worm drive. A new electro-welded transport is easily adjusted for balance. New special hold-down rods keep elevator leg from bouncing and jumping on derrick while transporting. Double No. 55 chain is standard. A speed jack or other speed reducer drive can be used. A twin V belt and sheave drive is optional. Also available is a motor mount with a special clutch.

Literature describing the new elevator may be had by writing the company for Bulletin HM-1155. *(Continued on page 286)*

Raking Magic

New Ford Mounted Side Delivery Rake

Here is another Ford-designed implement that is bringing new speed, new ease to hay making.

First, you'll notice the new Ford Side Delivery Rake is designed for modern "pick-up-and-go" farming. The entire rake "rides" to and from the field. Nothing drags behind to wear, to cause delay. And when raking, you can quickly lift the Ford Side Delivery Rake over obstructions . . . make short turns without cramping . . . rake cleaner on the curves . . . back into tight spots easily. But that's not all.

This new, improved rake moves hay a shorter distance from swath to windrow than ordinary side rakes. There's less whipping, less tossing of hay. It handles hay gently while raking at faster speeds. And its extra width gets all the hay with ease, placing the raked hay on top of stubble for faster curing.

There's much more, such as the exclusive four-blade rotor that strips hay from the teeth uniformly cleaner . . . two-speed PTO drive for all raking conditions . . . and nearly all bearings are sealed-for-life, greatly reducing the "greasing up" chore.

Through machines like this . . . better machines for better farming—Ford is helping farmers meet today's increasing challenges and tomorrow's greater opportunities.

The Ford Mounted Side Delivery Rake is raised and lowered by Ford Tractor hydraulic power. The rake "rides" to and from the field. It can be quickly lifted over rocks to avoid damage . . . turns can be made without cramping . . . backing is easy.

TRACTOR AND IMPLEMENT DIVISION
FORD MOTOR COMPANY,
Birmingham, Michigan

Ford Farming
IS NEW DAY FARMING

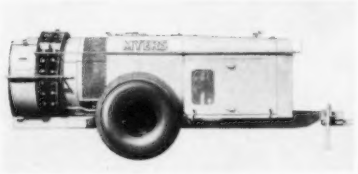
New Products and Catalogs

(Continued from page 284)

New Orchard Sprayers

The F. E. Myers & Bro. Co., 947 So. Orange St., Ashland, Ohio, has announced a series of ten new orchard air sprayers. Three of the new models can be used for applying dilute or semiconcentrate spray materials. The others are designed as semiconcentrate sprayers.

A special air outlet case can be adjusted to provide a varied range of spray patterns. Two 26-in centrifugal fans are used to distribute spray droplets from either side of the sprayer or both sides simultaneously in a range of degrees, depending upon the size of trees being sprayed. The new sprayers normally will deliver 42 percent of the chemically saturated air to the top one-third of the tree, 33 percent to the middle one-third and 25 percent to the bottom. This,



too, can be adjusted, according to the spraying requirements.

With the new sprayers, the grower has a choice of 300, 400 or 500-gal tanks. The sprayers are available in three classes: 26,000, 30,000 or 45,000 cu ft of air per minute.

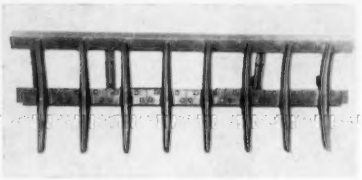
Small Engine Oil Filter

Luber-Finer, Inc., 2514 S. Grand Ave., Los Angeles 7, Calif., has announced a new model, 272-C, oil filter unit for mobile, stationary and marine engines with up to 3-gal crankcase capacity.

The new filter features single-bolt closure, screw-in pack replacement, positive-sealing O-ring-type gasket, one-piece extruded steel housing and rugged mounting bracket design.

Tool Bar Rake Attachment

Fleco Corp., Jacksonville, Fla., has developed a tool bar rake attachment for use with a Caterpiller D4 tractor equipped with a No. 4 tool bar. The new rake penetrates up to 12 in of ground and combs roots, branches and trees from the soil, stacking the debris in dirt-free piles for burning. It can be used also for removal of trees. The rake can be interchanged readily with the D4 tool bar dozer by attaching on the swinging draft members of the tool bar.



New Submersible Pump

The Dayton Pump & Mfg. Co., Dayton, Ohio, has introduced a new submersible pump, called the Dolphin, built for 4-in wells ranging to a depth of 500 ft.

The impeller, which is hydraulically balanced, is made of nylon. The case is microsmooth, corrosionproof stainless steel. A double-quad diffuser permits water to travel the shortest possible distance at high velocity after it leaves the impeller. Features include an electronically tested lifetime seal, a dielectric fluid-filled motor, and a stainless steel shaft. Capacities range up to 1,000 gph and pressures up to 80 lb can be obtained. Pumps are available in ½, ¾, 1, 1½, and 2-hp models. The number of stages varies from seven to 21.

Flavor and quality of milk is maintained in chromium-nickel stainless steel tanks that carry bulk milk from farm to city dairy. This stainless steel pick-up tank truck . . . complete with sample compartment, pump and hose . . . is a product of Stainless & Steel Products Co., St. Paul, Minn.

3,000 gallons of milk loaded in minutes... stainless steel saves labor, cuts pick-up cost

TODAY'S MODERN FARMER replaces labor with equipment. For example, instead of storing milk in cans, he uses a chromium-nickel stainless steel milkhouse tank. This saves work, yet allows quicker handling, better cooling and results in a higher and more uniform quality of milk.

Every other day, contents of the milkhouse tank are pumped directly into the dairy's pick-up tank—likewise made from chromium-nickel stainless steel.

Use of stainless not only maintains the flavor of milk intact, but also provides a money-saving combination of strength, corrosion-resistance and sanitation, highly desirable in dairy and allied equipment subject to all sorts of handling.

Easy to clean and keep clean, chromium-nickel stainless steels resist attack by food acids, cleaning solutions and the atmosphere. What's more, the high mechanical properties of stainless steels allow you to cut bulk and deadweight without sacrificing strength or durability.

Fabrication of stainless isn't difficult. It's just different. The manufacturer of the tank truck above, for instance, shears, rolls, and punches Types 302 and 304 stainless . . . in 12 and 14 gages . . . on equipment suited to handle $\frac{3}{8}$" carbon steel.

There's no need to put off using stainless steels where you want long, trouble-free performance. Leading steel companies produce austenitic chromium-nickel stainless steels in all commercial forms.

INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N.Y.

NEW BULLETINS

Tractor Power for Power Take-Off Driven Pumps by R. W. White and E. H. Kidder, Michigan Cooperative Extension Service (East Lansing) Extension Bulletin No. 338.

This bulletin presents information on speed increasers between the tractor and the pump, correct and incorrect alignment of PTO shaft; safety precautions and a table giving recommended maximum hp ratings for PTO pump use on most tractors manufactured since 1940. Copies can be obtained from Extension Office, Department of Agricultural Engineering, Michigan State University, East Lansing, Mich.

Hose Pump for Applying Nitrogen Solutions by Charles W. Gantt, Jr., Walter C. Hulburt and Henry D. Bowen. Farmers' Bulletin No. 2096, U. S. Department of Agriculture, Washington, D. C. (January, 1956). The 10-page bulletin explains the operation, features and pump regulation of a hose pump that measures nitrogen solutions in a manner whereby rollers revolving on a reel push equal amounts of solution along as many hoses as can be supported. As the reel turns the rollers move along the hoses. The hoses close when a roller comes in contact with them, and they open again after the roller passes. A pumping action results which pulls and pushes the solution forward and discharges it at the open ends of the hoses.

NIAE Bulletins. The following bulletins have been received recently from the National Institute of Agricultural Engineering, Wrest Park, Silsoe, Bedfordshire, England.

Performance of an Air Blast Nozzle, Part I. Experimental Methods and Preliminary Results—Technical Memorandum No. 125.

Soil Loads on Plough Bodies, Part I. Methods of Measurement—Technical Memorandum No. 105.

A Study of the Factors Affecting the Rate of Picking on a Potato Harvester—Report No. 55.

The Performance of a Moisture Meter of the Hair Hygrometer Type in Surface Wet Grain—Technical Memorandum No. 124.

A Drill for Trueness-To-Type Cereal Plots—Technical Memorandum No. 126.

Irrigation of Hay and Pasture Crops in Idaho by Victor I. Myers and Dell G. Shockley, Idaho Agricultural Experiment Station Bulletin No. 249 (December, 1955). The 28-page bulletin is written to provide information which can be used by technicians and farmers as a basis for designing and laying out sound conservation irrigation systems and in establishing effective and efficient water management practices on Idaho farms. It is intended to fill the need for a single publication to bring together all the data and facts relative to irrigation of forage crops.

Harvesting Cotton with Mechanical Strippers and Pickers, by H. P. Smith and D. I. Dudley. Texas Agricultural Experiment Station and The Texas A & M College System Progress Report 1838 (January, 1956). The 7-page mimeograph report revealed work done with an experimental stripper roll which uses strips of rubber running the full length of the roll and radiating about one inch from a central core. Three types of stripper rolls and one type of picker spindle were used in comparison tests. Results of experiments at College Station and Denton with several varieties of cotton favored the rubber paddle stripper.

Factors Affecting Tobacco Cultivation by Robert W. Wilson. North Carolina Agricultural Experiment Station (Raleigh) Technical Bulletin No. 116 (December, 1955). The 28-page bulletin reports on a series of experiments started in 1949 to learn some of the effects of cultivation upon the production of flue-cured tobacco. Three soil groups were studied under a variety of treatments. Treatments included no cultivation, weeds, scraped, shallow cultivation with high lay-by, shallow cultivation with no lay-by, deep cultivation with high lay-by, deep cultivation with no lay-by, chemical weed control, and straw covered.

Farm Electric Motors by William H. Knight and J. W. Martin. University of Idaho farm electrification leaflet No. 32 (December, 1955). The report contains helpful information on the selection of electric motors by size, type, speed and application. Various electric motors are described, their operation explained in an easy-to-understand manner and typical farm applications are cited.

Effects of Heat-Treatment on the Viability of Rice by Vernon H. McFarlane, Joseph T. Hogan, and Taylor A. McLemore. Technical Bulletin No. 1129, U.S. Department of Agriculture, Washington, D. C. (December, 1955). The 52-page bulletin reports on experiments conducted during three rice-harvesting seasons for the purpose of demonstrating the effects of time and temperature of heating on the viability of rough, or paddy, rice of different moisture contents. Heat-treatments were made on the premises of the Rice Experiment Station at Crowley, La.

With the ASAE Sections

(Continued from page 267)

agement and has a background in the field of process analysis in both industry and education, will speak on opportunities of process analysis and plant design in industry. Many of these ideas will have applications in agriculture and should be interesting to agricultural engineers who have problems in agricultural processing. Henry J. Barre, ASAE vice-president and agricultural engineering consultant, will discuss the integration of processing equipment and structures for materials handling.

One feature of the afternoon program will be a tour through the Ford Motor Company's scientific laboratory. This unit is new and will present many new ideas used in the research and development of agricultural implements. The dinner speaker will be Irving A. Duffy, vice-president, Ford Motor Co. and general manager, Tractor and Implement Division. Wayne H. Worthington, president of ASAE, will be present.

For the ladies a series of tours are being outlined to include such places of interest as the Henry Ford Museum, Greenfield Village, Ford Rotunda, a conducted tour of the Ford Rouge Plant and for those who like to shop, a trip to the Northland Shopping Center.

Quad City Section

An afternoon and evening meeting will be held by the Quad City Section April 20. A plant tour of the International Harvester Farmall Tractor Works, Rock Island, is scheduled to begin at noon.

The evolution of a planetary transmission and the future tractors and power will be topics of papers presented preceding a social hour and dinner. Following dinner, Jimmy L. Butt, ASAE secretary, will address the section. A business meeting and election of officers will follow.

Alabama Section

A meeting of the Alabama Section will be held at Dothan, April 20 and 21. A tour of the manufacturing facilities of the W. F. Covington Planter Co., Inc. in Dothan is planned for Friday afternoon. A social hour and banquet will be sponsored by the Dothan Chamber of Commerce and the W. F. Covington Planter Co. on Friday evening.

A business meeting and election of officers is planned for Saturday morning, April 21. K. J. McGilvray, Alabama Power Co., is chairman of local arrangements and highly responsible for promoting the courtesy social hour and banquet.

Florida Section

A meeting of the Florida Section will be held April 20 and 21 at the University of Florida, Gainesville. Papers to be given during the Friday afternoon session include: Aluminum for agricultural usage by W. S. Ellis and W. L. Willis, Aluminum Co. of America; types, grades and uses of plywood, by Herman W. Glover, Douglas Fir Plywood Assn; the role of the electric co-op in farm electrification by E. N. Butler, Suwannee Valley Co-op; progress report of the Florida Water Resources Study Commission by David B. Smith, director; and irrigation for pasture by J. M. Myers, Florida Agricultural Experiment Station.

The annual section dinner will be held at 7:00 p.m. at the student service center. Albert Wass de Czege, agricultural engineer and author, will speak about the agricultural engineer in Europe.

The Saturday morning program consists of papers on agricultural engineering at the University of Florida by Frazier Rogers, head, agricultural engineering; cotton ginning research in the Southeast by J. A. Luscombe, engineer in charge, Southeast Cotton Ginning Laboratory, Clemson, S.C.; automation in agriculture in the Florida Everglades by John W. Randolph, Everglades Experiment Station; and potato harvesting and handling machinery by John S. Norton, Florida Agricultural Experiment Station.

Minnesota Section

An afternoon and evening meeting is planned for the Minnesota Section on Thursday, April 26, in room 217 of the agricultural engineering building on the Farm Campus, University of Minnesota, St. Paul.

The meeting will begin with a coffee hour at 2:45 p.m. At 3:45 p.m. a tour of selected research projects in agricultural engineering will be conducted. A colored sound movie, entitled "Land of Plenty," will be shown at 5:00 p.m. This film was produced from the Michigan Centennial in 1955 showing the progress of agriculture during the past 100 years and the role of agricultural engineering in this development.

Dinner will be served in the Farm Campus cafeteria. Wayne H. Worthington, ASAE president, will be the speaker. A business meeting will follow.

Holding More

today's key to efficient farming . . . and profit

Never has the need for farming efficiency been more pressing. Business farmers, regardless of acreage, are taking a new look at every possible way to avoid loss and waste . . . to *hold* more of what they get.

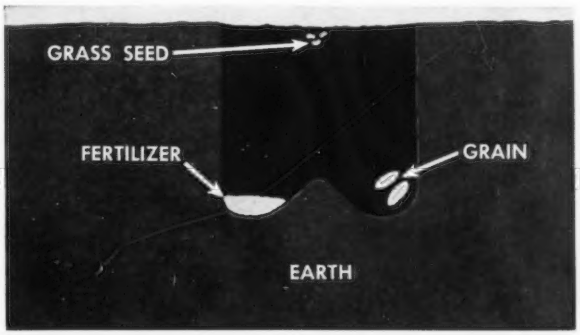
They want new ways of holding more rainfall and irrigation water in their soils, better methods of maintaining the viability in costly seed, and of keeping for crop use more of the nutrients applied as fertilizer.

At harvest time, this problem of holding more becomes one of saving feeding value, kernel loss, or crop grade. And throughout the year, it is expressed as a growing concern about wasted time and tractor fuel.

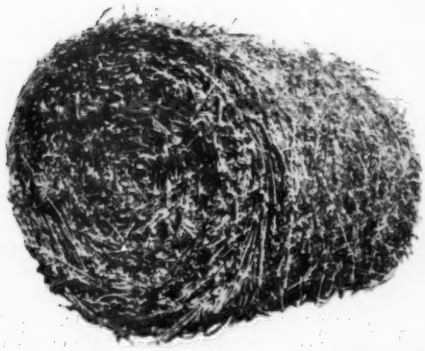
Shown here are a few of the recent Allis-Chalmers contributions that have taken on new importance with this challenge of today — this need of *holding more* on the business farms of our nation.

ALLIS-CHALMERS, FARM EQUIPMENT DIVISION
MILWAUKEE 1, WISCONSIN

Subsoiling — a means of holding more moisture in many soils; assures greater utilization of cropland by speeding drainage of "wet spots" in fields.



Band Seeding— a proved way to preserve the viability of seed and get more from fertilizer application — becomes a standard operation with the ALL-CROP drill.



The Round Bale — produced by the ROTO-BALER — captures and holds more leaves and blossoms; protects nutritious protein in a weather-proof package that sheds rain, can't buckle, and self-feeds to cattle without waste.

The TRACTION BOOSTER system — plus this new remote ram principle — reduces fuel consumption on heavy tillage such as plowing and discing. SNAP-COUPLER hitch shortens get-ready time; allows more time for productive work.

ALLIS-CHALMERS

ROTO-BALER, ALL-CROP and TRACTION BOOSTER are Allis-Chalmers trademarks.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Allen, James R. — Junior engineer, John Deere Waterloo Tractor Works, Waterloo, Iowa

Anderson, Leslie D.—Cooperative development engineer, East Central Oklahoma Electric Cooperative, Inc., Okmulgee. Okla.

Baker, Ervin — Manager, Sylvania Electric Products, Inc., 60 Boston St., Salem, Mass.

Beshore, George W. — Assistant editor, *Capper's Farmer*, 912 Kansas Ave., Topeka, Kans.

Carter, Robert M., III—Standards engineer, Bryan Chucking Grinder, Co., Springfield, Vt., (Mail) Perkinsville, Vt.

Collins, Raymond H.—Sales engineer, Greer Hydraulics, Inc., Chicago, Ill., (Mail) 7027 Wilson Terrace, Morton Grove, Ill.

Craig, John H. — Chief engineer, Howard Rotavator Co., Inc., 1600 E. Davis St., Arlington Heights, Ill.

Fahy, F. E.—Assistant division head, research dept., Bethlehem Steel Co., Bethlehem, Pa.

Farmer, Kenneth H.—Manager, engineering dept., Sears Roebuck & Co., Greensboro, N. C.

Grover, Satish C. — Senior mechanic on farm machinery, Government of India (Mail) A14 Jangpura Estension, New Delhi-14, India

Gupta, Shri M.—Graduate student in agricultural engineering, Pennsylvania State University, University Park, Pa.

Hammad, Mohammed M.—Agricultural engineer, Ministry of Agriculture, Khartoum, Sudan

Hulsing, Kenneth L.—Staff engineer, Detroit-Diesel Engine Div., (Mail) 1010 Church St., Plymouth, Michigan

Kanz, Randolph A.—Agricultural engineer, RSDA-SCS, Temple, Texas (Mail) Box 753, Floydada, Texas

Kaufmann, Henry H.—Manager, Cargill, Inc., 200 Grain Exchange, Minneapolis, Minn.

Retzer, Henry J.—Instructor in agricultural engineering, Pennsylvania State University, University Park, Pa.

Schaad, Raymond E. — Technical advisor, Universal Oil Products Co., 30 Algonquin Rd., Des Plaines, Ill.

Shaw, G. Jackson, Jr.—Soil conservationist, SCS. (Mail) Belmont Trailer Ct., Kinston, N. C.

Stiles, Jared W.—Director of research, Co-op Grange League Federation Exchange, Inc., Terrace Hill, Ithaca, N. Y.

Wilson, Edward T. — Sales co-ordinator, Pennsylvania Power & Light Co., 901 Hamilton St., Allentown, Pa.

Transfer of Membership

Brown, Charles W.—Associate agricultural engineer, Tennessee Agricultural Experiment Station, Knoxville, Tenn. (Associate Member to Member)

Calderwood, David L.—Agricultural engineer, USDA, (Mail) Texas A & M College, College Station, Texas. (Associate Member to Member)

Ferguson, William—Agricultural engineer, Her Majesty's Overseas Civil Service, Agricultural Engineering Branch, agricultural dept., Samaru, Zaria, Nigeria

Thom, LeRoy W.—Manager and partner of T-L Irrigation Co., 1103 E. South St., Hastings, Nebr. (Associate Member to Member)

NEW BOOKS

An Introduction to Fluvial Hydraulics by Serge Leliavsky. Cloth, xii+257 pages, 5½ x 8½ inches. Illustrated and indexed. Oxford University Press, 114 Fifth Ave., New York 11, N.Y. $4.80.

This book presents a comprehensive survey of the various theories, methods and facts bearing upon the flow of water in erodible channels. Two alternative approaches to the sediment-transportation problem are presented. The difference between traction and suspension is explained. Other phases discussed include: dunes, ripples, scour criteria, bed load, side-slope stability, sediment suspension, and the empirical approach to the sediment-transportation problem. One chapter is devoted to three-dimensional characteristics of the water flow in rivers and the non-parallelism principle.

Proceedings of the American Society for Engineering Education, 1955 (Vol. 62). Cloth, 832 pages, 6x9 inches. Illustrated and indexed by subject and author. Published by the American Society for Engineering Education, Urbana, Ill.

Well over 100 articles of the various aspects of engineering education that were presented at the Annual Meeting of ASEE, at the University of Illinois, in June, 1954, and at ASEE Section meetings, as well as selected articles that appeared in the *Journal of Engineering Education* are contained in this book. Also included are the high lights of the 62nd Annual Meeting; Minutes of executive board meetings; minutes of general council meetings; interim report on the committee on evaluation of engineering education; news of Engineers' Joint Council, and various reports of committees and conferences.

PERSONNEL SERVICE BULLETIN

NOTE: In this bulletin the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated.

POSITIONS OPEN—1955—AUGUST—O324-745, 334-746, 338-747, 346-749, 346-750, 347-751, 350-752. SEPTEMBER—O-331-754, 335-756, 352-758, 372-759. OCTOBER—O-402-762, 405-765, 409-766, 409-767, 409-768, 407-769, 407-770, 413-772, 415-773. NOVEMBER—O-385-775, 430-776, 439-777, 451-779, 453-780, 453-781, 454-782, 448-783, 463-784, 463-785. DECEMBER—O-476-786, 503-787. 1956 — JANUARY — O-455-789, 534-790, 537-791. FEBRUARY—O-4-601, 4-602, 6-603, 12-604, 15-605, 29-606, 22-607. MARCH O-60-608, 60-609, 70-611, 80-612.

POSITIONS WANTED — 1955 — SEPTEMBER — W-351-41. OCTOBER—W-383-43, 398-45. NOVEMBER—W-429-51, 445-52, 450-53. DECEMBER—W-458-56, 486-57, 489-58, 480-59. 1956—JANUARY—W-457-60, 528-61, 529-62. FEBRUARY—W-506-64, 8-1, 9-2, 14-4, 18-5, 30-6, 37-7. MARCH—W-67-9, 55-10.

NEW POSITIONS OPEN

PROJECT ENGINEERS, experienced senior and associate, for design and development of special field machinery for the sugar cane industry in Hawaii. Previous experience in the design and development of construction or agricultural machinery important. Salary open. O-105-613

AGRICULTURAL or MECHANICAL ENGINEER for research in handling, transportation and storage of perishable agricultural commodities, with USDA. Includes study of refrigeration requirements and equipment, moisture loss and related subjects. Location in East. Some travel involved. Age under 35. BS deg in agricultural or mechanical engineering required. Advanced degree preferred. Experience and training in refrigeration and instrumentation. Interest in research. Civil Service position with usual opportunities and benefits. Salary $4525-5440 depending on qualifications. O-115-614

AGRICULTURAL ENGINEER wanted by eastern Canadian agricultural college, in the field of power and machinery with special interest in tillage, seeding and fertilizer application. Graduate degree preferred, but not necessary if willing to undertake graduate work later. About 25 percent of time teaching, balance in research. Good opportunities for initiative and advancement. Salary dependent upon qualifications and experience. O-117-615

AGRICULTURAL ENGINEER required by eastern Canadian agricultural college in the field of structures. Teaching 25 percent of time, balance in structural design for planning service and research. Graduate degree preferred, though not essential if willing to undertake graduate work later. Good opportunity for initiative and advancement. Salary dependent on qualifications and experience. O-117-616

SERVICE ENGINEER, for agricultural research of established producer and fabricator of aluminum. Work includes liaison with district sales offices, jobbers, dealers, colleges, county agents, vo-ag teachers, etc., expansion of farm building plans service, and technical writing. Age 25-35. BS deg in agricultural engineering, with major in farm structures. Experience 4-6 yr as farm building extension engineer or building product sales engineering or development. Farm or other light building construction experience desirable. Requires tact, presentable appearance, and ability to address small groups. Chicago location, travel about 50 percent of time. Real opportunity with expanding business. Salary open.. O-119-617

AGRICULTURAL ENGINEER for structures research and teaching at southern land grant university. MS degree in agricultural engineering required. Additional experience desirable but not mandatory. Must have imagination, be willing to try new things, have desire for research, and ability to get along with students and his fellow staff members. Excellent opportunity to develop this line of work. Rank and salary depending upon individual's education, experience and ability. Tentatively set up as assistant or associate professor. Twelve months appointment. Excellent provision for health and life insurance and retirement. Salary open. O-127-618

ASSISTANT AGRICULTURAL ENGINEER for research in farm structures in a Southeastern Land Grant College. Age under 45. BS deg in agricultural engineering. MS deg. or experience in related research, preferred. Usual personal qualifications for public service. Must have desire for research and ability to cooperate with others. Normal opportunity for advancement. Salary open. O-136-619

NEW POSITIONS WANTED

AGRICULTURAL ENGINEER for design, development or service in farm structures, with industry in West or Midwest. Married. Age 35. No disability. BS deg in agricultural engineering, 1949, Purdue University. Farm background. Engineering aide, Bureau of Reclamation 1 yr. Agricultural engineer, Farmers Home Administration, 5 yr; agricultural engineer, Near East Foundation, 2 yr; war non-commissioned service in Army, 3½ yr. Available August 1. Salary $5500. W-50-11

AGRICULTURAL ENGINEER for design, development, extension, sales, or service in power and machinery, farm structures, or soil and water field with industry or public service in New England. Limited travel. Married. Age 26. No disability. BS deg in agricultural engineering, 1951, University of Vermont. Summer work experience in agriculture. Enlisted and non-commissioned service in Army 2 yr. Mechanical engineering experience 2½ yr in design of machine tools. Available on reasonable notice. Salary $5000. W-101-12

AGRICULTURAL ENGINEER for development, extension, teaching, or research in power and machinery with industry or public service in Midwest or West. Limited travel. Married. Age 29. No disability. BS deg in agricultural engineering, 1948, Iowa State College. Farm background. Sales engineer on dairy equipment 6 mo. Veteran's on-farm training instructor 3½ yr. Territory man for major farm equipment manufacturer 2½ yr. War service as aviation cadet, 10 mo. Available July 1. Salary open. W-90-13

AGRICULTURAL ENGINEER for design, development, or research in soil and water field with manufacturer or consultant, preferably in West. Willing to travel. Single. Age 25. No disability. BS deg in agricultural and civil engineering expected in June, Utah State Agricultural College. Summer experience 1955 on efficiency studies with manufacturer. Part time work on irrigation project, 1956. Commissioned service in Army, 2 yr. Available June 11. Salary open. W-96-14

AGRICULTURAL ENGINEER for extension, teaching or sales in power machinery or soil and water field with college or manufacturer in U.S.A., Latin America or Europe. Married, Age 39. No disability. BS deg in agriculture, 1946, Michigan State University. Farm background. With an Eastern state university as an extension agricultural engineer, 6 yr. Currently with International Cooperation Administration overseas as farm machinery specialist. War commissioned service in Air Force 3 yr. Available Oct. 1956. Salary open. W-43-15

AGRICULTURAL ENGINEER for design, development, research, extension, or teaching in farm structures with industry or public service anywhere in U.S.A. Prefer small community, limited travel. Married. Age 38. No disability. BS deg, 1947; MS deg, 1948, Iowa State College. Major in farm structures, minor in civil engineering. Farming 10 yr. Research and teaching 5 yr. Sales and engineering industry 2 yr. Farm building contractor 2 yr. War enlisted service in Army, 3 yr. Available July 1. Salary open. W-53-16

Technical Report on Fan Clutches

Warner Electric Brake and Clutch Co., Beloit, Wis., will send on request to interested readers a copy of a technical report it has compiled embodying a thorough analysis of the engineering features and operating advantages of custom-engineered fan clutches now available for various internal-combustion-engine applications. The report features the advantages gained through the application of a fan clutch to an engine, including reduction in fuel consumption, increase in power, quieter operation, and faster warmup, including the engineering reasons for these advantages. Fan-clutch operation and the methods of control are described in detail, with varying types of mountings listed.

Who Should Join ASAE

If any one of the following descriptions covers your present work:

- Development, design, and application of farm tractors and implements and their components
- Design and improvement of farm buildings
- Engineered improvements for soil and water conservation and use
- Creating applications for electricity in farm practice and living—

then you can derive much benefit from membership in ASAE, and the Society cordially invites you to make application. For further information write

AMERICAN SOCIETY OF
AGRICULTURAL ENGINEERS
St. Joseph, Michigan

Index to Advertisers

Professional Directory

RATES: 80 cents per line per issue; 40 cents per line to ASAE members. Minimum charge, five-line basis. Uniform style setup. Copy must be received by first of month of publication.

FACTS

about

NEW DEPARTURE

BALL BEARINGS

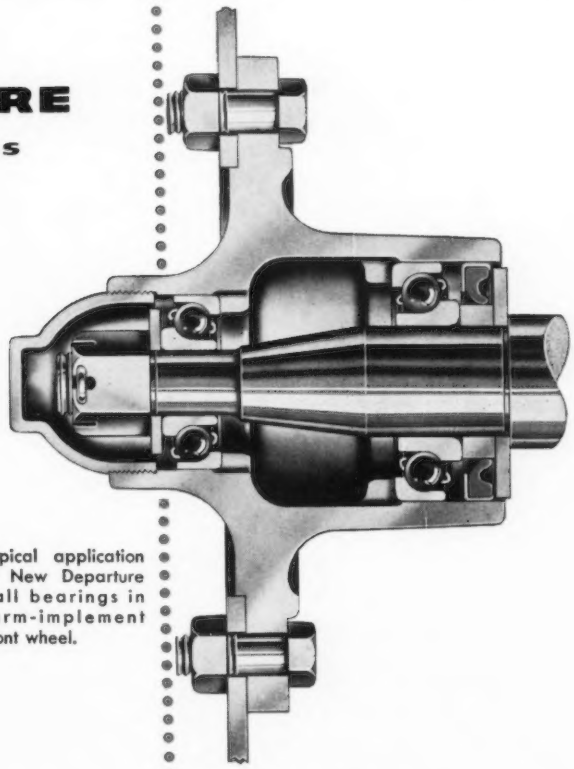
PERFORMANCE-PROVED IN MILLIONS OF WHEELS

More than 200 million New Departure front-wheel-type ball bearings have proved in a variety of vehicles that they deliver advantages unsurpassed by any other wheel bearing applied in pairs.

First, they require virtually no attention for adjustment for wear or for relubrication in service throughout the life of the product to which they are applied.

Second, these service-proved ball bearings are perfectly adapted to simple, low-cost farm-implement wheel mountings using standard parts. And New Departure ball bearings are equally adapted to numerous applications other than wheels where bearings are mounted in a similar manner.

Call on New Departure's storehouse of engineering knowledge for help with your farm implement bearing problems.

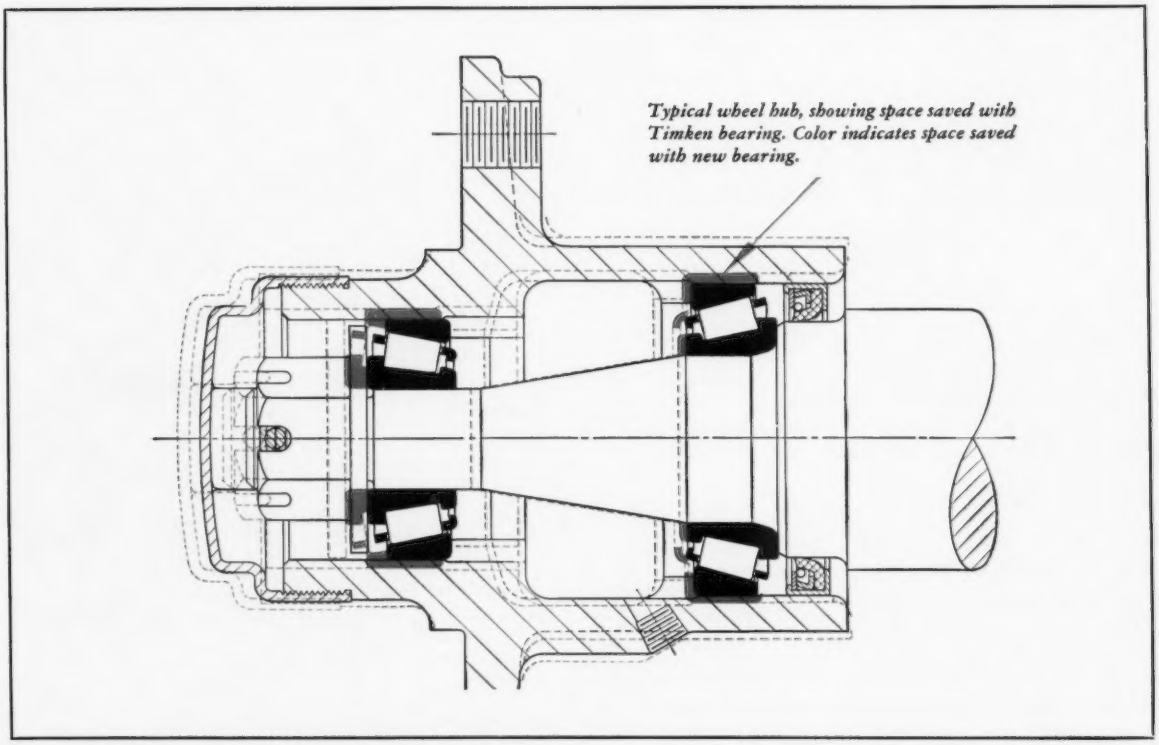


Typical application of New Departure ball bearings in farm-implement front wheel.

New Departure angular-contact front wheel bearings withstand rugged radial, thrust, and shock loads year after year without need for adjustment. No lubricant required in space between bearings.

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

Four new TIMKEN® bearings cost less, permit savings in related parts, too



Typical wheel hub, showing space saved with Timken bearing. Color indicates space saved with new bearing.

New capacity-packed bearings take up less space than previous designs of same bore sizes

FOUR new Timken® tapered roller bearings are now available in bore sizes of ¾", 27/32", 1¼" and 1⅜". And they cost less than previous bearings of the same bore sizes. Because they take up less space and weigh less, they permit application designs that save in related parts, too. And never has so much bearing capacity been packed into so little space.

These new Timken bearings offer exciting opportunities for savings through redesign of present tapered roller bearing applications. One example is shown in the above diagram of a typical wheel hub. Seals can be smaller and cheaper, hubs can require less metal and less machining, spindles can be made shorter and less costly to machine. All these savings are in addition to the lower cost of the bearings themselves.

Many engineers have already taken advantage of these possibilities and well over 11,000,000 of the new bearings are proving themselves in automobile front wheels and other applications.

The new Timken bearings also make it possible for you to enjoy the advantages of tapered roller bearings in many new applications—and at minimum cost.

Auxiliary parts for use with the new Timken bearings are available from the Timken Company and major closure manufacturers. For full information on the new low-cost Timken bearings and help in designing them into your product, write today to The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

TIMKEN ... your number 1 bearing **VALUE**

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL AND THRUST → LOADS OR ANY COMBINATION